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# CHEMISTRY today

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# CHEMISTRY MUSING

## PROBLEM SET 55

Chemistry Musing was started from August '13 issue of Chemistry Today. The aim of Chemistry Musing is to augment the chances of bright students preparing for JEE (Main and Advanced) / NEET / AIIMS / JIPMER with additional study material. In every issue of Chemistry Today, 10 challenging problems are proposed in various topics of JEE (Main and Advanced) / NEET. The detailed solutions of these problems will be published in next issue of Chemistry Today. The readers who have solved five or more problems may send their solutions. The names of those who send atleast five correct solutions will be published in the next issue. We hope that our readers will enrich their problem solving skills through "Chemistry Musing" and stand in better stead while facing the competitive exams.

### JEE MAIN/NEET

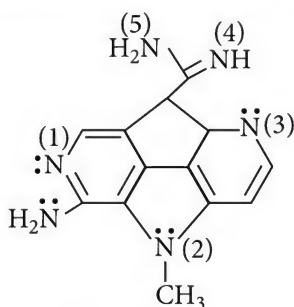
1. The reaction,  $\text{cis-X} \xrightleftharpoons[k_b]{k_f} \text{trans-X}$  is first order in both directions. At 25°C, the equilibrium constant is 0.10 and the rate constant,  $k_f = 3 \times 10^{-4} \text{ s}^{-1}$ . In an experiment starting with the pure *cis*-form, how long would it take for half of the equilibrium amount of the *trans*-isomer to be formed?

- (a) 150 sec (b) 200 sec  
(c) 240 sec (d) 210 sec

2. 1 mole of an ideal gas A ( $C_{v,m} = 3R$ ) and 2 moles of an ideal gas B are  $\left(C_{v,m} = \frac{3}{2}R\right)$  taken in a container and expanded reversibly and adiabatically from 1 litre to 4 litre starting from initial temperature of 320 K.  $\Delta U$  for the process is

- (a) -240 R (b) 240 R  
(c) 480 R (d) -960 R

3. The decreasing order of basic strength is

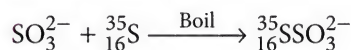


- (a) (1) > (5) > (3) > (4) > (2)  
(b) (4) > (1) > (5) > (3) > (2)  
(c) (5) > (4) > (1) > (2) > (3)  
(d) (4) > (5) > (3) > (1) > (2)

4. A metal ion shows different co-ordination number with different oxidation state. With same ligand in one oxidation state it does not show any isomerism

but in other oxidation state with same ligand it shows isomerism, from two of them choose the compound with same ligand which has  $d_{x^2-y^2}$  at higher energy than  $d_{z^2}$  orbital of metal :

- (a) *bis*(glycinato) platinum (II)  
(b) *bis*(ethylenediammine) platinum (II) ion  
(c) *tris*(glycinato) platinum (IV) ion  
(d) *tris*(ethylenediammine) platinum (IV) ion
5. Consider the following reaction to prepare labile thiosulphate :



( ${}^{35}_{16}\text{S}$  = labile sulphur, S = normal sulphur)

If thiosulphate so formed is decomposed by treatment with dil.  $\text{H}_2\text{SO}_4$  or dil. HCl then :

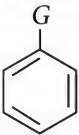
- (a)  $\text{SO}_2 + {}^{35}_{16}\text{S} + \text{H}_2\text{O}$  are produced  
(b)  ${}^{35}_{16}\text{S}_2 + \text{S} + \text{H}_2\text{O}$  are produced  
(c)  $\text{SO}_2 + {}^{35}_{16}\text{SO}_2 + \text{S} + {}^{35}_{16}\text{S} + \text{H}_2\text{O}$  are produced  
(d)  $\text{SO}_2 + {}^{35}_{16}\text{SO}_2 + \text{S} + \text{H}_2\text{O}$  are produced

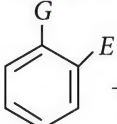
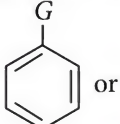
### JEE ADVANCED

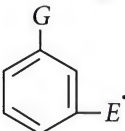
6.  $\text{H}_2$  gas is mixed with air at 25°C under pressure of one atmosphere and exploded in a closed vessel. The enthalpy of the reaction  $\text{H}_{2(g)} + 1/2\text{O}_{2(g)} \longrightarrow \text{H}_2\text{O}_{(g)}$  at constant volume,  $\Delta U_{298} = -240.6 \text{ kJ}$  and  $C_v$  for  $\text{H}_2\text{O}$  vapour and  $\text{N}_2$  in the temperature range 298 K and 3,200 K are  $39.1 \text{ J K}^{-1}$  and  $26.4 \text{ J K}^{-1}$ , respectively. What will be the explosion temperature under adiabatic conditions?

- (a) 2700 K (b) 2916 K  
(c) 3020 K (d) 5120 K

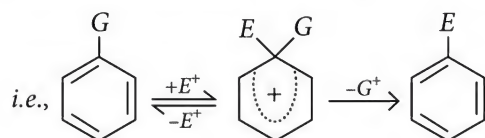
## COMPREHENSION

It is very well known that when a compound  reacts with an electrophile then we either get *ortho*-or

*para*-substituted product, i.e.,  +  or

we get a *meta*-substituted product. i.e., 

This depends on the electron releasing or electron-withdrawing power of the group, i.e., +R/-R or +M/-M effect of group G. There is another theory that is the electrophile attacks the ring carbon where the substituent G is already attached.

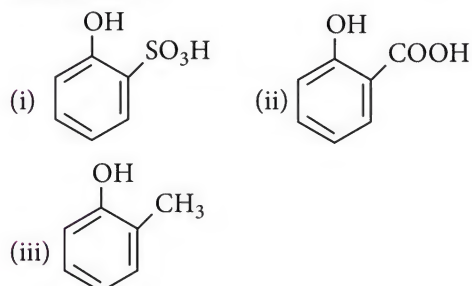


This is called *ipso* substitution reaction.

7. The factor which is expected to promote *ipso* substitution is

- the group G should be a strong electron withdrawing group
- a group which is highly electron withdrawing should be attached at *ortho*- or *para*-position with respect to the group G
- the group G should leave as  $G^+$  easily, i.e.,  $G^+$  should be highly stable
- the group G should leave easily, i.e.,  $G^+$  should be highly unstable.

8. In which of the following can you expect *ipso* substitution?



- (i) only
- (ii) only
- (i) and (ii) only
- All of these

## INTEGER VALUE

- Calculate percentage of  $S_N1$  product if (R)-2-chloro butane on reaction with NaOH/ $H_2O$  and acetone gives 98 % inverted product.
- How many isomers are possible for disubstituted borazole  $B_3N_3H_4X_2$ ?

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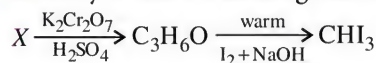
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- Converting *n*-hexane into benzene in the presence of chromium oxide on alumina support is an example of a/an
  - hydrogenation reaction
  - isomerisation reaction
  - dehydrogenation reaction
  - substitution reaction.

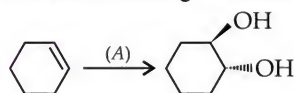
- Oxidation of benzene with air at 725 K in presence of  $V_2O_5$  as catalyst gives
  - maleic acid
  - malic acid
  - malonic acid
  - maleic anhydride.

- Identify X in the following reaction sequence :



- $CH_3CH_2CH_2OH$
  - $CH_3CHOHCH_3$
  - $CH_3OCH_2CH_3$
  - $CH_3CH_2CHO$
- In a reaction which is carried out at 400 K, 0.0001% of the total number of collisions are effective. The energy of activation of the reaction is
    - zero
    - 7.37 kcal/mol
    - 9.212 kcal/mol
    - 11.05 kcal/mol
  - Phenol gives *sym*-tribromophenol when treated with bromine in aqueous solution but only *o*- and *p*-bromophenols in  $CCl_4$  solution because
    - in aqueous solution the bromine is ionised
    - in aqueous solution, phenol exists in equilibrium with phenoxide ion which has more activating effect
    - in  $CCl_4$ , the electrophilicity of  $Br_2$  increases
    - in  $CCl_4$ , the other positions of benzene rings are blocked by the solvent.

- For the following conversion,

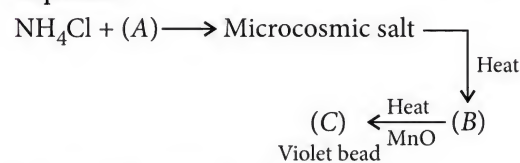


reagent (A) is

- $OsO_4$
- $O_3$

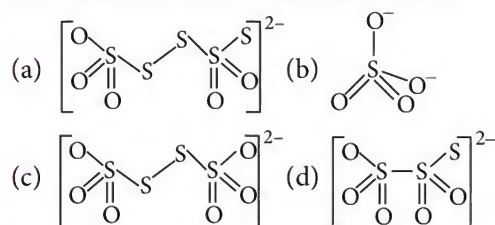
- $I_2$  and silver acetate under wet condition
- peracid following by acid hydrolysis.

- Identify A, B and C in the following reaction sequence :

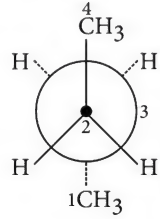


- $Na_3PO_4, NaPO_3, Mn_3(PO_4)_2$
  - $Na_2HPO_4, Na_3PO_4, Mn_3(PO_4)_2$
  - $Na_2HPO_4, NaPO_3, Mn(PO_3)_2$
  - $Na_2HPO_4, NaPO_3, NaMnPO_4$
- Which of the following is an incorrect statement?
    - Non-ionic detergents are neutral.
    - The hydrophilic portion of a non-ionic detergent functions by a hydrogen bonding mechanism.
    - Cationic detergents have a positively charged water soluble portion.
    - LABS detergent are not biodegradable.
  - For the complex,  $[Co(NH_3)_5CO_3]ClO_4$  the coordination number, oxidation number, number of *d*-electrons and number of unpaired electrons on the metal are, respectively
    - 6, 3, 6, 0
    - 7, 2, 7, 1
    - 7, 1, 6, 4
    - 6, 3, 6, 4

- The structure of the tetrathionate ion is



- The dipole moment of HBr is  $0.78 \times 10^{-18}$  esu cm and interatomic spacing is 1.41 Å. The % ionic character of HBr is
  - 7.5
  - 11.5
  - 15
  - 27

12. The disperse phase in colloidal iron(III) hydroxide and colloidal gold is positively and negatively charged respectively. Which of the following is not correct?
- Magnesium chloride solution coagulates the gold sol more readily than iron(III) hydroxide sol.
  - Sodium sulphate solution causes coagulation in both sols.
  - Mixing of the sols has no effect.
  - Coagulation in both sols can be brought about by electrophoresis.
13. In a cubic crystal of CsCl (density =  $3.97 \text{ g/cm}^3$ ) the eight corners are occupied by  $\text{Cl}^-$  ions with  $\text{Cs}^+$  ions at the centre. The distance between the neighbouring  $\text{Cs}^+$  and  $\text{Cl}^-$  ions is
- $4.21 \text{ \AA}$
  - $3.00 \text{ \AA}$
  - $3.57 \text{ \AA}$
  - $4.57 \text{ \AA}$
14. The type of hybrid orbitals used by chlorine atom in  $\text{ClO}_3^-$  is
- $sp^3$
  - $sp^2$
  - $sp$
  - none of these.
15. If  $\Delta G = \Delta H - T\Delta S$  and  $\Delta G = \Delta H + T \left[ \frac{d(\Delta G)}{dT} \right]_p$  then variation of EMF of a cell, with temperature  $T$ , is given by
- $\frac{\Delta S}{nF}$
  - $-\frac{\Delta S}{nF}$
  - $\frac{\Delta H}{nF}$
  - $\frac{\Delta G}{nF}$
16. When  $\text{K}_2\text{CrO}_4$  is added to  $\text{CuSO}_4$  solution, there is formation of  $\text{CuCrO}_4$  and  $\text{CuCr}_2\text{O}_7$ . Formation of  $\text{CuCr}_2\text{O}_7$  is due to
- basic nature of  $\text{CuSO}_4$  solution which converts  $\text{CrO}_4^{2-}$  to  $\text{Cr}_2\text{O}_7^{2-}$
  - acidic nature of  $\text{CuSO}_4$  solution which converts  $\text{CrO}_4^{2-}$  to  $\text{Cr}_2\text{O}_7^{2-}$
  - $\text{CuSO}_4$  has a typical property of converting  $\text{CrO}_4^{2-}$  to  $\text{Cr}_2\text{O}_7^{2-}$
  - none of the above is correct.
17. Time taken for an electron to complete one revolution in the Bohr orbit of hydrogen atom is
- $\frac{4\pi^2 mr^2}{nh}$
  - $\frac{nh}{4\pi^2 mr}$
  - $\frac{2\pi mr}{n^2 h^2}$
  - $\frac{h}{2\pi mr}$
18. The acid used for the determination of molecular weight of amines is
- $\text{H}_2\text{PtCl}_6$
  - picric acid
  - $\text{HAuCl}_4$
  - $\text{H}_2\text{SO}_4$
19. A complex of a certain metal ion has a magnetic moment of 4.90 B.M. Another complex of the same metal in the same oxidation state has a zero magnetic moment. The central metal ion could be
- $\text{Cr}^{3+}$
  - $\text{Mn}^{2+}$
  - $\text{Fe}^{3+}$
  - $\text{Fe}^{2+}$
20. Which of the following reactions is a condensation reaction?
- $\text{HCHO} \longrightarrow \text{Paraformaldehyde}$
  - $\text{CH}_3\text{CHO} \longrightarrow \text{Paraldehyde}$
  - $\text{CH}_3\text{COCH}_3 \longrightarrow \text{Mesityl oxide}$
  - $\text{CH}_2=\text{CH}_2 \longrightarrow \text{Polyethylene}$
21. The molar enthalpies of combustion of  $\text{C}_2\text{H}_{2(g)}$ ,  $\text{C}_{(\text{graphite})}$  and  $\text{H}_{2(g)}$  are  $-1300$ ,  $-394$  and  $-286 \text{ kJ mol}^{-1}$ , respectively. The standard enthalpy of formation of  $\text{C}_2\text{H}_{2(g)}$  is
- $-226 \text{ kJ mol}^{-1}$
  - $-626 \text{ kJ mol}^{-1}$
  - $226 \text{ kJ mol}^{-1}$
  - $-2374 \text{ kJ mol}^{-1}$
22. The structure of intermediate acetyl nitrene is
- $\text{CH}_3-\text{CO}-\ddot{\text{N}}:$
  - $\text{CH}_3-\text{CO}-\ddot{\text{N}}:$
  - $\text{CH}_3-\text{CO}-\ddot{\text{N}}:$
  - $\text{CH}_3-\text{CO}=\text{N}:$
23. In the given conformation, if  $\text{C}_2$  is rotated about  $\text{C}_2-\text{C}_3$  bond anticlockwise by an angle of  $120^\circ$  then the conformation obtained is
- fully eclipsed conformation
  - partially eclipsed conformation
  - gauche conformation
  - staggered conformation.
- 
24. Which of the following halogen oxides is ionic?
- $\text{ClO}_2$
  - $\text{BrO}_2$
  - $\text{I}_2\text{O}_5$
  - $\text{I}_4\text{O}_9$
25. The IUPAC name of  $\text{K}_2[\text{Cr}(\text{CN})_2\text{O}_2(\text{O})_2\text{NH}_3]$  is
- potassium amminedicyanodioxoperochromate(VI)
  - potassium amminedicyanotetroxochromium(III)
  - potassium amminedicyanochromate(IV)
  - potassium amminocyanodiaperochromate(VI).
26. Product obtained on the addition of an aqueous alkali to benzaldehyde followed by acid hydrolysis is
- benzoic acid
  - benzyl alcohol
  - benzyl benzoate
  - all of these.



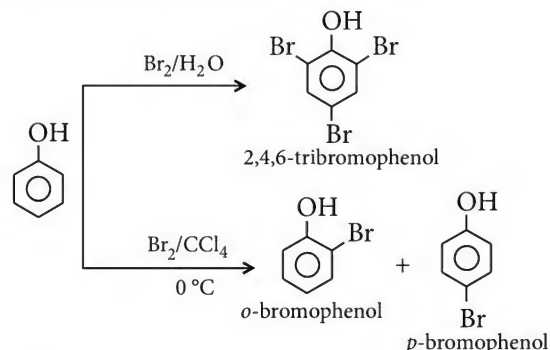
27. The correct name for the following hydrocarbon is  
 (a) tricyclo [4.1.0] heptane  
 (b) bicyclo [5.2.1] heptane  
 (c) bicyclo [4.1.0] heptane  
 (d) bicyclo [4.1.0] hexane.
28. When  $N_2^+$  is formed from  $N_2$ , bond order \_\_\_\_ and when  $O_2^+$  is formed from  $O_2$ , bond order \_\_\_\_.  
 (a) increases, increases (b) decreases, decreases  
 (c) increases, decreases (d) decreases, increases.
29. The value of the 'spin only' magnetic moment for one of the following configurations is 2.84 B.M. The correct one is  
 (a)  $d^4$  (in strong field ligand)  
 (b)  $d^4$  (in weak field ligand)  
 (c)  $d^3$  (in weak as well as in strong field ligand)  
 (d)  $d^5$  (in strong field ligand).
30. The aqueous solution of  $CuCrO_4$  is green because it contains  
 (a) green  $Cu^{2+}$  ions (b) green  $CrO_4^{2-}$  ions  
 (c) blue  $Cu^{2+}$  ions and green  $CrO_4^{2-}$  ions  
 (d) blue  $Cu^{2+}$  ions and yellow  $CrO_4^{2-}$  ions.



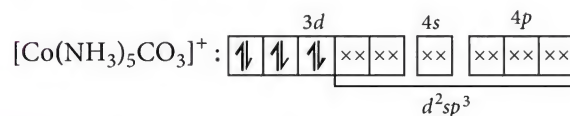
### SOLUTIONS

1. (c) : Conversion of *n*-hexane into benzene involves removal of six H-atoms. Therefore, this process is either called dehydrogenation or aromatization.
2. (d) :
- $$2 \text{ C}_6\text{H}_6 + 9 \text{ O}_2 \xrightarrow[725 \text{ K}]{\text{V}_2\text{O}_5} 2 \text{ C}_6\text{H}_4\text{O}_2 + 4 \text{ H}_2\text{O} + 4 \text{ CO}_2$$
- Maleic anhydride
3. (b) : Since  $C_3H_6O$  on treatment with  $I_2 + NaOH$  gives  $CHI_3$ , therefore,  $C_3H_6O$  must be a dimethyl ketone, i.e.,  $CH_3COCH_3$ . If this is so then, X must be  $CH_3CHOHCH_3$ .
4. (d) :  $f = e^{-E_a/RT}$   
 $\ln \frac{1}{f} = \frac{E_a}{RT} \Rightarrow \ln \frac{1}{0.0001 \times \frac{1}{100}} = \frac{E_a}{2 \times 400}$   
 $E_a = 11.05 \text{ kcal/mol}$
5. (b) : In aqueous solution, phenol ionises to form phenoxide ion. Due to the presence of negative charge, the oxygen of the phenoxide ion donates electrons to the benzene ring to a large extent. As a result, the ring gets highly activated and hence, trisubstitution occurs.

On the other hand, in non-polar solvents the ionization of phenol is greatly suppressed. Consequently, the ring is activated only slightly and hence, only monosubstitution occurs.

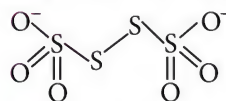


6. (d) : Hydroxylation of alkene using  $H_2O_2/HCO_2H$  (peracid) is *anti*-addition.
- Cyclohexene  $\xrightarrow[HCO_2H]{H_2O_2}$  1, 2-Cyclohexanediol (*trans*)
7. (d) :  $NH_4Cl + Na_2HPO_4 \rightarrow NaNH_4HPO_4 \cdot 4H_2O$   
 (A) Microcosmic salt  
 $\downarrow \text{Heat}$   
 $NaMnPO_4 \xleftarrow[MnO]{\text{Heat}} NaPO_3$   
 Violet bead (C) (B)
8. (d) : All LABS detergents are not biodegradable and some of them cause pollution and are hazardous to human civilization.
9. (a) : Coordination number of Co in  $[Co(NH_3)_5CO_3]ClO_4 = 6$   
 Oxidation number of Co in  $[Co(NH_3)_5CO_3]^+$   
 $\Rightarrow x - 2 = +1 \Rightarrow x = +3$   
 $Co^{3+} (Z = 27) : 3d^6$   
 $\therefore$  Number of *d*-electrons = 6



There are no unpaired electrons.

10. (c) : Tetrathionate ion ( $S_4O_6^{2-}$ ):



11. (b) : Dipole moment of HBr (when 100% ionic)  
 $= 4.8 \times 10^{-10} \times 1.41 \times 10^{-8} \text{ cm}$   
 $= 6.768 \times 10^{-18} \text{ esu cm}$

Actual dipole moment =  $0.78 \times 10^{-18}$  esu cm

$\therefore$  % ionic character

$$= \frac{0.78 \times 10^{-18}}{6.768 \times 10^{-18}} \times 100 = 11.52 \approx 11.5$$

12. (c) : When positive and negative sols are mixed, they coagulate each other.

13. (c) : In a unit cell, there is one  $\text{Cs}^+$  (from body centre) and  $\left(\frac{1}{8} \times 8 = 1\right)$  one  $\text{Cl}^-$ , i.e., one CsCl molecule.

$$\therefore \rho = \frac{Z \times M}{a^3 \times N_A}$$

$$\therefore 3.97 = \frac{1 \times 168.36}{a^3 \times 6.023 \times 10^{23}}$$

$$\Rightarrow a = 4.13 \times 10^{-8} \text{ cm} = 4.13 \text{ \AA}$$

For a cube of side length 4.13 Å,

$$\text{Diagonal} = \sqrt{3}a = \sqrt{3} \times 4.13 = 7.15 \text{ \AA}$$

As it is a bcc with  $\text{Cs}^+$  at centre (radius  $r^+$ ) and  $\text{Cl}^-$  at corners (radius  $r^-$ ), so

$$2r^+ + 2r^- = 7.15 \text{ \AA} \text{ or } r^+ + r^- = 3.57 \text{ \AA}$$

i.e., Distance between neighbouring  $\text{Cs}^+$  and  $\text{Cl}^-$  = 3.57 Å

14. (a) : Hybridisation ( $H$ ) =  $GA + (VE - V - C)/2$

GA = Group atoms attached to central atom

VE = Valence electrons of central atom

V = Valency of central atom

C = Charge over the molecule

$$\therefore H = 3 + (7 - 6 - (-1))/2 = 4$$

As molecule is having hybridisation number 4. So, it has  $sp^3$  hybridisation.

15. (a) : On comparison,

$$\Delta S = - \left[ \frac{d(\Delta G)}{dT} \right]; \Delta S = - \frac{d(-nFE)}{dT} = nF \left( \frac{dE}{dT} \right)$$

$$\therefore \left( \frac{dE}{dT} \right) = \frac{\Delta S}{nF}$$

16. (b)

17. (a) : By Bohr's postulate,

$$mvr = n \frac{h}{2\pi} \text{ or } v = \frac{nh}{2\pi mr}$$

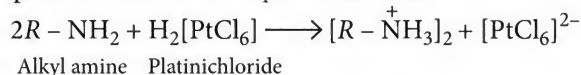
No. of revolutions per second

$$= \frac{\text{velocity}}{\text{circumference of the orbit}}$$

$$= \frac{v}{2\pi r} = \frac{nh}{2\pi mr} \times \frac{1}{2\pi r} = \frac{nh}{4\pi^2 mr^2}$$

$$\therefore \text{Time taken for one revolution} = \frac{4\pi^2 mr^2}{nh}$$

18. (a) : The acid used is  $\text{H}_2\text{PtCl}_6$ . It is a solution of platinum chloride,  $\text{PtCl}_4$  in conc. HCl.



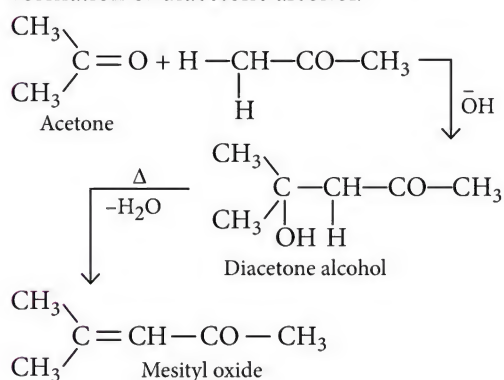
Chloroplatinates on ignition leave a residue of metallic platinum. This reaction is employed in determining molecular weight of amines.

19. (d) : Magnetic moment = 4.90 B.M. ; 4 unpaired electrons

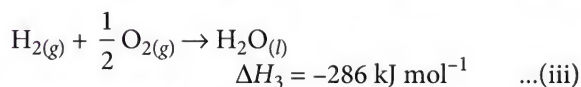
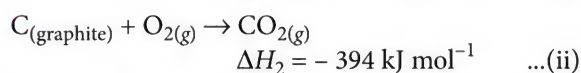
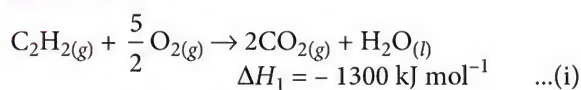
Magnetic moment = 0 ; 0 unpaired electron

To have either four or zero unpaired electrons, the configuration must be  $d^6$ . Hence, the central metal ion should be  $\text{Fe}^{2+}$ .

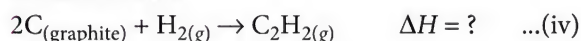
20. (c) : The formation of mesityl oxide from acetone is a condensation reaction. On treatment with conc. NaOH in the presence of dry HCl gas, acetone forms mesityl oxide through the intermediate formation of diacetone alcohol.



21. (c) : Given :



we have to find



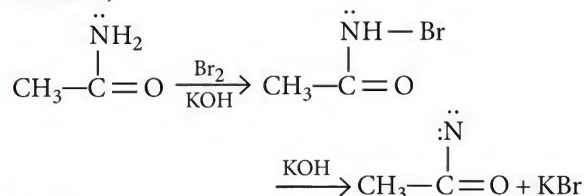
In order to obtain equation (iv),

Multiply eq. (ii) by 2 then add it to eqn (iii), now subtract eqn (i) from it.

$$\begin{aligned} \text{Hence, } \Delta H &= (-2 \times 394 - 286 + 1300) \text{ kJ mol}^{-1} \\ &= 226 \text{ kJ mol}^{-1} \end{aligned}$$



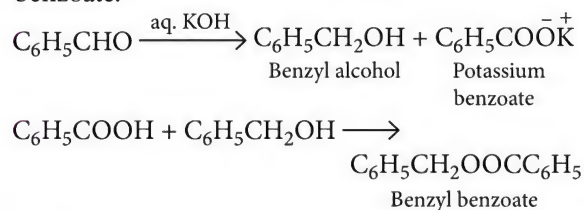
22. (c) : The structure of intermediate acetyl nitrene is  $\text{CH}_3-\text{CO}-\ddot{\text{N}}$ . It is formed by the following reaction,



23. (c)  
24. (d) :  $\text{I}_4\text{O}_9$  is iodate of tripositive iodine i.e.,  $\text{I}^{3+}(\text{IO}_3^-)_3$ .

25. (a)

26. (d) : When an aqueous alkali solution is added to benzaldehyde, Cannizzaro reaction takes place and the products formed are potassium benzoate and benzyl alcohol. Potassium benzoate on acidic hydrolysis produces benzoic acid, which further reacts with benzyl alcohol produces benzyl benzoate.



27. (c)  
28. (d) : Molecular orbital electronic configuration of  $\text{N}_2$  is  $\sigma 1s^2, \sigma^* 1s^2, \sigma 2s^2, \sigma^* 2s^2, \pi 2p_x^2 \approx \pi 2p_y^2, \sigma 2p_z^2$ . Molecular orbital electronic configuration of  $\text{O}_2$  is  $\sigma 1s^2, \sigma^* 1s^2, \sigma 2s^2, \sigma^* 2s^2, \sigma 2p_z^2, \pi 2p_x^2 \approx \pi 2p_y^2, \pi^* 2p_x^1 \approx \pi^* 2p_y^1$ . When  $\text{N}_2^+$  is formed from  $\text{N}_2$ , electron is removed from  $\sigma$ -bonding M.O. and hence, bond order decreases while when  $\text{O}_2^+$  is formed from  $\text{O}_2$ , electron is removed from  $\pi$ -antibonding M.O. and hence, bond order increases.

29. (a) : Spin only magnetic moment =  $\sqrt{n(n+2)}$  B.M.  
where,  $n$  = number of unpaired electrons.

$$\sqrt{n(n+2)} = 2.84 \text{ B.M. (given)}$$

Hence,  $n = 2$

In octahedral complex, a strong field ligand results in a low spin complex.

Thus,  $d^4$  configuration has two unpaired electrons.

30. (d) :  $\text{Cu}^{2+}$  (aqueous solution)  $\rightarrow$  blue  
 $\text{CrO}_4^{2-}$  (aqueous solution)  $\rightarrow$  yellow  
Blue + yellow  $\rightarrow$  green

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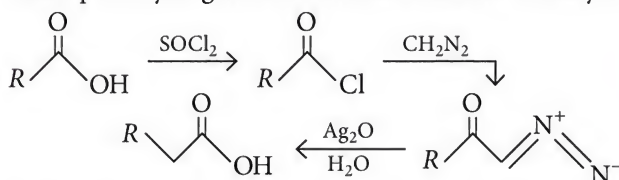
### \*Conditions apply

- Payment will be made after the MCQs are published.
- Kindly note that each question should be complete.
- Payment will be made only for complete questions.
- Preference will be given to the reader sending the maximum complete and correct questions. Other conditions apply. The decision of the Editor, MTG shall be final and binding.

# SOME EMINENT NAME REACTIONS

## ARNDT-EISTERT REACTION

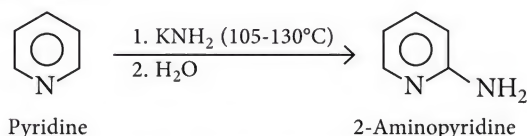
Arndt-Eistert synthesis is a convenient way of converting an aliphatic, aromatic, alicyclic or even a heterocyclic acid into the next higher homologue. The first step of the synthesis involves reaction between acid chloride and diazomethane to give a diazoketone. The diazoketone then undergoes Wolff rearrangement when warmed in the presence of water and  $\text{Ag}_2\text{O}$  (or with benzoate and triethylamine) to give the next higher homologous acid. Often photolysis gives better result than silver catalyst.



It must be ensured that R should not contain any functional group that is acidic enough to react with diazomethane.

## CHICHIBABIN REACTION

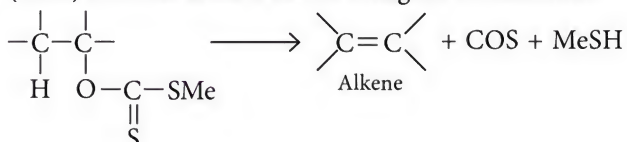
Amination of pyridine and other heterocyclic compounds containing nitrogen using sodium amide is called Chichibabin reaction, named after Alexei E. Chichibabin.



Actually sodium salts are formed, which when hydrolysed with water give amines.

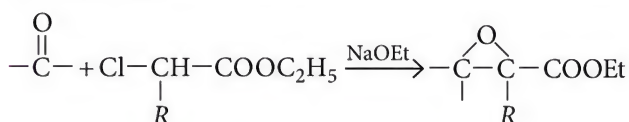
## CHUGAEV ELIMINATION

Pyrolysis of the xanthate to give olefin, carbonyl sulphide (COS) and the thiol is called Chugaev elimination.



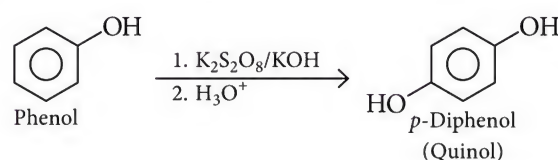
## DARZENS CONDENSATION

The condensation of aldehyde or ketone with an  $\alpha$ -halo ester to produce an  $\alpha, \beta$ -epoxy ester or a glycidic ester is the Darzens condensation. The reaction takes place in presence of very strong bases such as sodium ethoxide or sodamide.



## ELBS PERSULPHATE OXIDATION

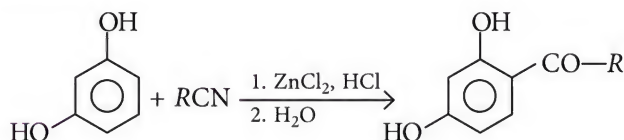
The Elbs persulphate oxidation is the chemical reaction of phenols with alkaline potassium persulphate to form *p*-diphenols.



The reaction is generally carried out by adding an aqueous solution of  $\text{K}_2\text{S}_2\text{O}_8$  to a cold alkaline solution of phenol followed by acidification.

## HOUBEN-HOESCH REACTION

Condensation of cyanides with polyhydric phenols in presence of  $\text{ZnCl}_2$  and  $\text{HCl}$  to give ketones is called Houben-Hoesch reaction. Consider the reaction with resorcinol :

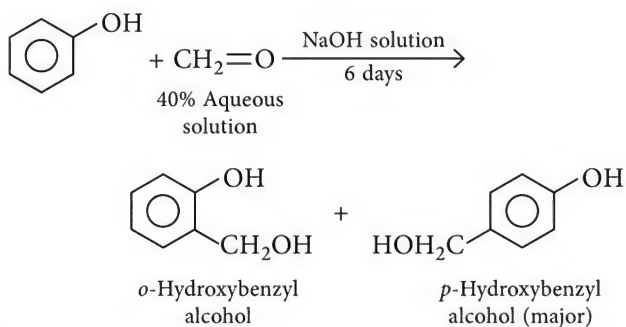


It is an extension of Gatterman's phenolic aldehyde synthesis.



## LEDERER-MANASSE REACTION

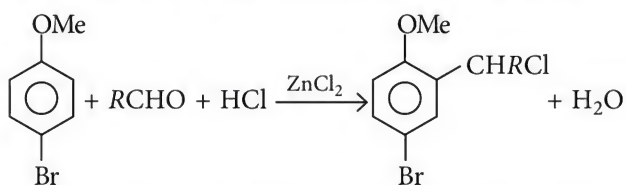
Hydroxymethylation of phenols using formaldehyde in presence of acid or base catalyst is called Lederer-Manasse reaction.



The reaction is slow and takes place at low temperature.

## QUELET REACTION

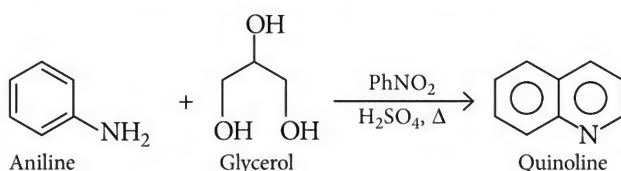
Passage of dry hydrochloric acid through a solution of a phenolic ether and an aliphatic aldehyde in ligroin in the presence or absence of a dehydration catalyst to yield  $\alpha$ -chloroalkyl derivative by substitution in the *para*-position to the ether group or in the *ortho*-position in *para*-substituted phenolic ethers.



Ligroin is a volatile fraction of petroleum used as solvent.

## SKRAUP SYNTHESIS

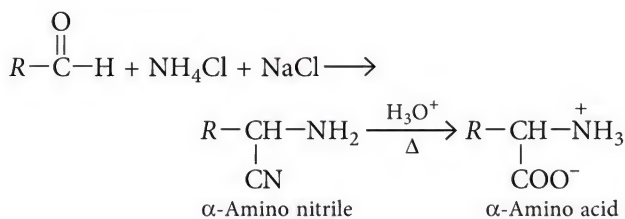
The synthesis of quinoline by heating aniline with glycerol and  $\text{H}_2\text{SO}_4$ , which acts as catalyst as well as dehydrating agent in presence of moderator  $\text{Fe(II)}$  sulphate is known as Skraup synthesis, named after Z. H. Skraup. Nitrobenzene acts as mild oxidant. Since the reaction can be violently exothermic, a moderator such as  $\text{Fe(II)}$  sulphate is usually added. Modern methods use  $\text{Fe(III)}$  sulphate instead of nitrobenzene as oxidant.



In a slightly different way than that of original Skraup synthesis, preformed acrolein is used instead of glycerol.

## STRECKER SYNTHESIS

Preparation of  $\alpha$ -amino nitriles by the treatment of an aldehyde and ketone with  $\text{CN}^-$  and  $\text{NH}_4\text{Cl}$  followed by hydrolysis is called Strecker synthesis, named after Adolph Strecker.



Cyanide ion acts as the source of the acid portion and ammonia is the ultimate source of amino group. While usage of  $\text{NH}_4\text{Cl}$  gives unsubstituted amino acids, *pri*- and *sec*- amines give substituted amino acids successfully.





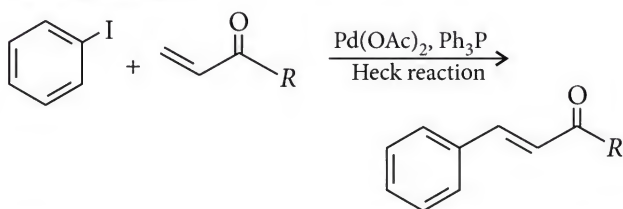
# CONCEPT BOOSTER

Hello students ! After the massive winter season how we all are waiting for the upcoming SEASON OF EXAMS hopefully our favourite season. Anyway this article is dedicated to a specific and one of the most wanted topics "ORGANOMETALLIC COMPOUNDS & THEIR REACTIONS". I have found you all are having so many doubts with the use of organometallic compounds. Hopefully this article will help you intensively. Keep practicing all my dear students & enjoy your study.

\*Arunava Sarkar

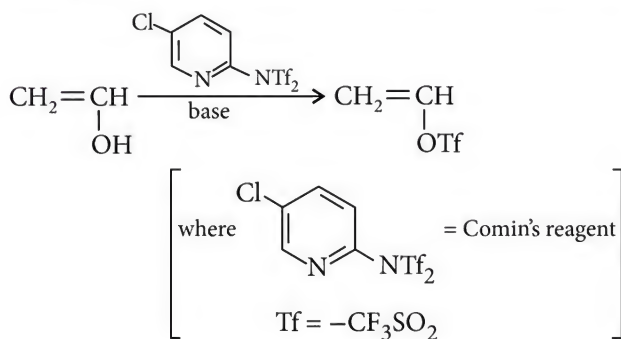
## A BRIEF OVERVIEW OF ORGANOMETALLIC REAGENTS AND ORGANOMETALLIC CHEMISTRY

Organometallic reactions are those where the metals act as catalysts. The most important thing is transition metal complexes and reagents can make impossible reactions occur easily. Take the following example at the beginning :

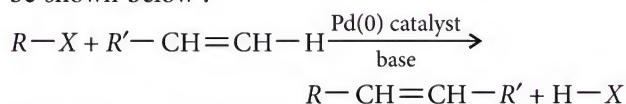


What you can see is Heck reaction couples an alkene with an organic halide or triflate to form a new alkene. Triflates are trifluoromethanesulphonate anions, conveniently denoted as  $\text{CF}_3\text{SO}_3^-$  or  $\text{TfO}^-$ .

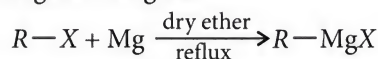
Triflates are non-basic very good leaving groups. We can say that triflates are oxygen based leaving groups and even better than halides. The basic funda is metals are inserted between  $\text{C}-\text{OSO}_2\text{CF}_3$  bond. Triflates are usually prepared conveniently with Comin's reagent :



In general, the simple outline of the Heck reaction can be shown below :

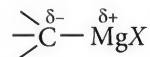


In general, whenever we say organometallic compounds, the first thing which comes to our mind is Grignard reagent. We'll have a quick look on the important parts of Grignard reagent :

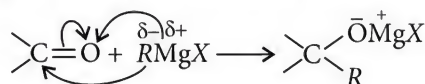


For a given halogen, the reactivity order of alkyl groups is  $-\text{CH}_3 > -\text{C}_2\text{H}_5 > -\text{C}_3\text{H}_7$  and for a given alkyl group, the reactivity order of halogens is  $\text{RI} > \text{RBr} > \text{RCl}$ .

As the reactions of Grignard reagent are concerned, the most important one is reaction with carbonyl compounds. This is actually nucleophilic addition reaction. Here, an important point should be understood. Normally, if you take  $\text{C}-\text{X}$  (X being the halogen) then the polarity is  $\text{C}^{\delta+}-\text{X}^{\delta-}$ . But, if you take Grignard reagent, then the polarity is as shown below :

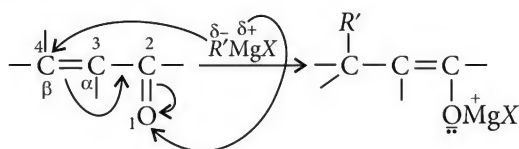


So, there is a polarity reversal. This is known as **umpolung**. So, Grignard reagent gives carbanion. Reaction between a carbonyl group and Grignard reagent takes place as shown below :

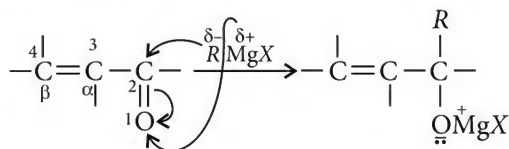




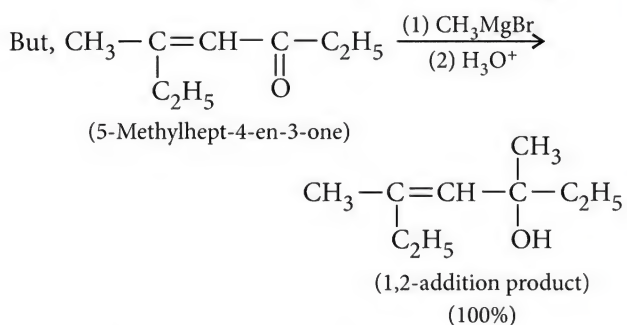
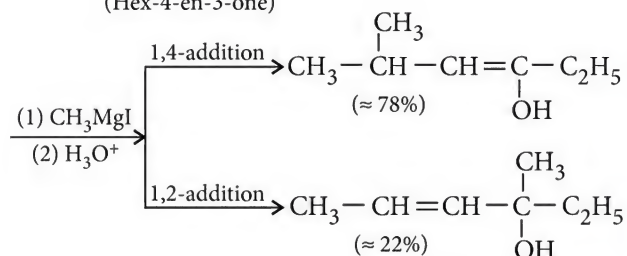
**1,4-addition :**



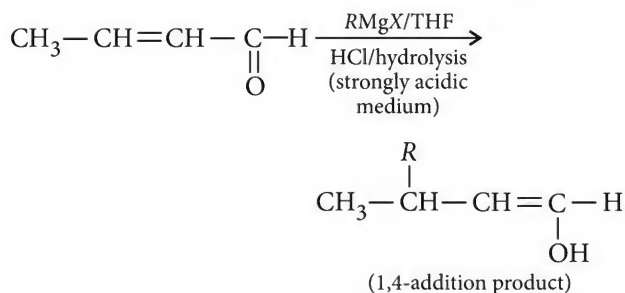
**1,2-addition :**


$$\text{CH}_3-\overset{1}{\text{CH}}=\text{CH}-\underset{\text{O}}{\underset{\parallel}{\text{C}}}-\text{CH}_2\text{CH}_3$$

(Hex-4-en-3-one)


$$\text{CH}_3-\text{CH}=\text{CH}-\underset{\text{O}}{\underset{\parallel}{\text{C}}}-\text{H} \xrightarrow[\text{NH}_4\text{Cl/hydrolysis}]{\text{RMgX/THF}} \text{CH}_3-\text{CH}=\text{CH}-\underset{\text{OH}}{\underset{|}{\text{CH}}}-\text{R}$$

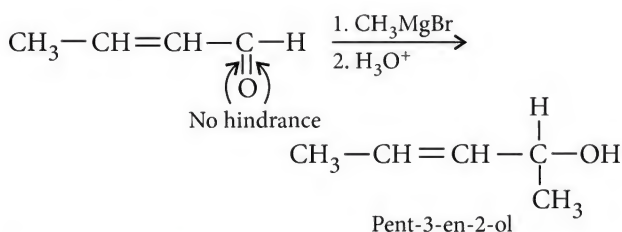
(1,2-addition product)



Now, there is another aspect which gives another concept. In case of  $\alpha,\beta$ -unsaturated aldehyde (like crotonaldehyde) where there is no hindrance at the  $\text{>C=O}$  group, there the major product is unsaturated alcohol via 1,2-addition.

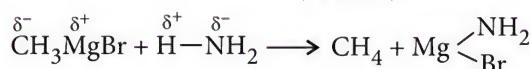
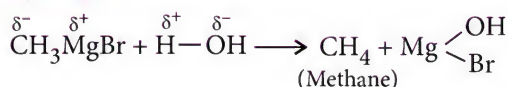
## EXAM CORNER 2018

Exam	Date
VITEEE	4 <sup>th</sup> to 15 <sup>th</sup> April
JEE Main	8 <sup>th</sup> April (Offline), 15 <sup>th</sup> & 16 <sup>th</sup> April (Online)
SRMJEEE	16 <sup>th</sup> to 30 <sup>th</sup> April
Karnataka CET	18 <sup>th</sup> & 19 <sup>th</sup> April
WBJEE	22 <sup>nd</sup> April
Kerala PET	23 <sup>rd</sup> & 24 <sup>th</sup> April
MHT CET	10 <sup>th</sup> May
COMEDK (Engg.)	13 <sup>th</sup> May
AMU (Engg.)	13 <sup>th</sup> May (Revised)
BITSAT	16 <sup>th</sup> to 31 <sup>st</sup> May
JEE Advanced	20 <sup>th</sup> May
AIIMS	27 <sup>th</sup> May
JIPMER	3 <sup>rd</sup> June



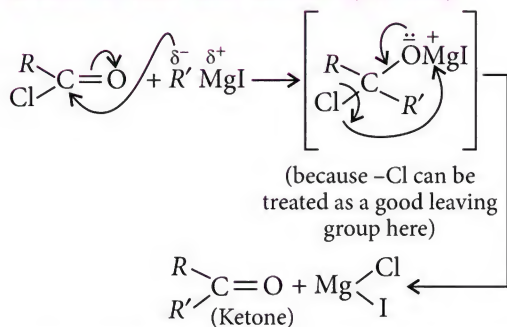
Now, we can take a look into the different reactions exhibited by Grignard reagent.

○ **Reaction with compounds containing active hydrogen**

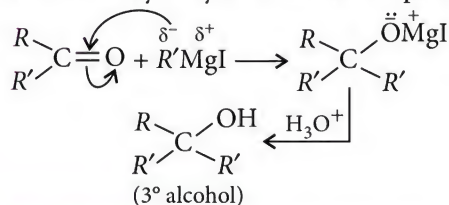


Similar reactions are obtained with 1° amines, alcohols, etc. containing active hydrogen. Look at a fact that if you fix the alkyl group of Grignard reagent as methyl, then everytime methane is the product. Now, if we take a known amount of the compound containing active hydrogen then by measuring the amount of methane liberated, we can find out the number of active hydrogens present in the compound. This is known as Zerewitinoff determination.

○ **Reaction with acid chloride (RCOCl)**

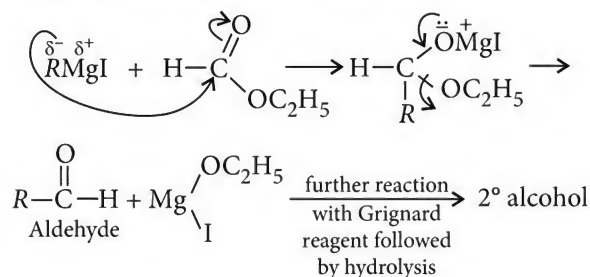


Now, if excess amount of Grignard reagent is present then after hydrolysis 3° alcohol is produced.

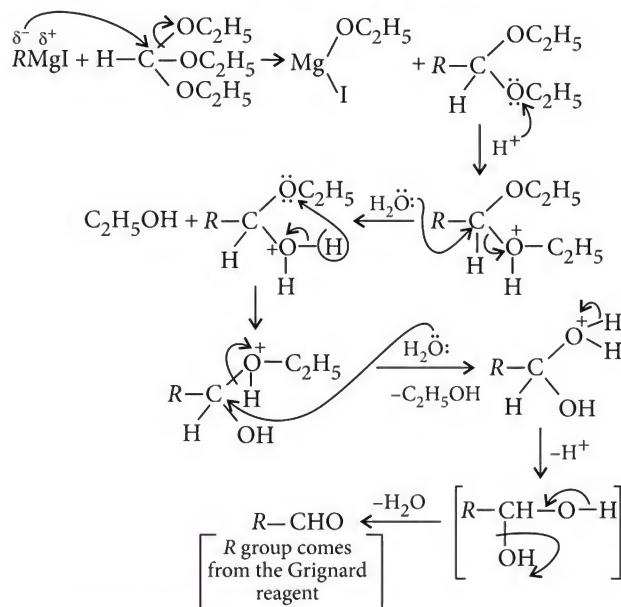


○ **Reaction with ester :** In this case, a diversified range of ester is found. We will take three major examples of esters to display the varieties of reaction of Grignard reagent.

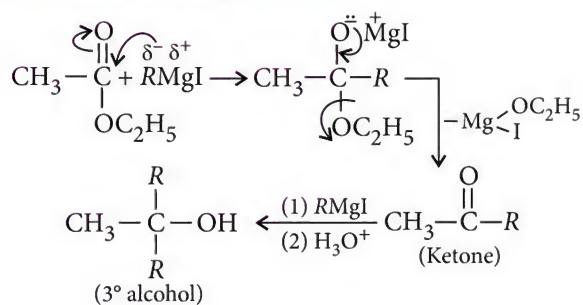
(a) **Reaction with ethyl formate**



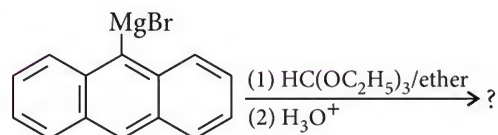
(b) **Reaction with ethyl ortho-formate**



○ **Reaction with ethyl acetate**



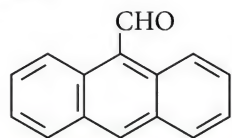
Q. Identify the product.



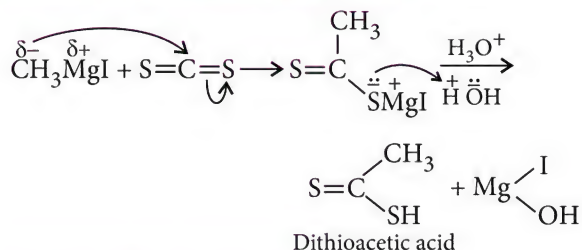
**Soln.:** Idea is very simple. Concept of using *ortho*-formate is, wherever -MgBr is attached, just add -CHO



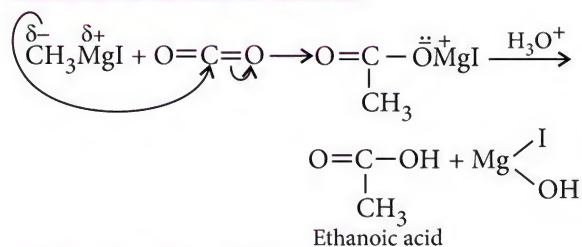
there. So, the product is



### ○ Reaction with carbon disulphide



### ○ Reaction with carbon dioxide

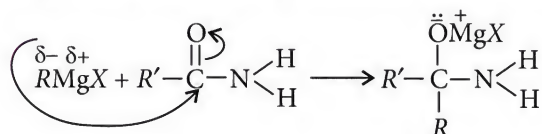


### ○ Reaction with acid amide

The first member of amide is formamide  $\left( \text{H}-\text{C}(=\text{O})-\text{N}(\text{H})_2 \right)$ . When Grignard reagent reacts with

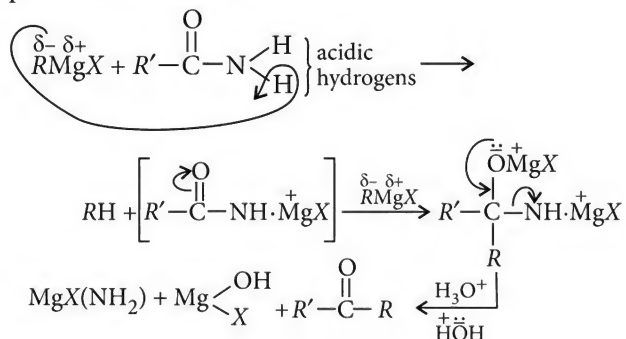
formamide, it gives aldehyde whereas with other amides, Grignard reagent gives ketone.

In general, the reaction proceeds as shown below :

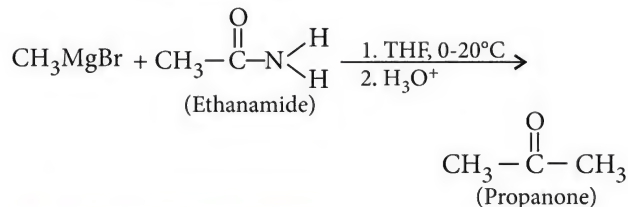
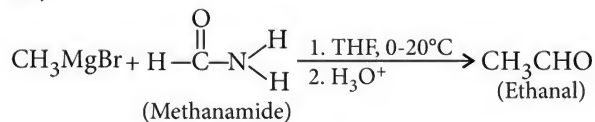


Look carefully!!

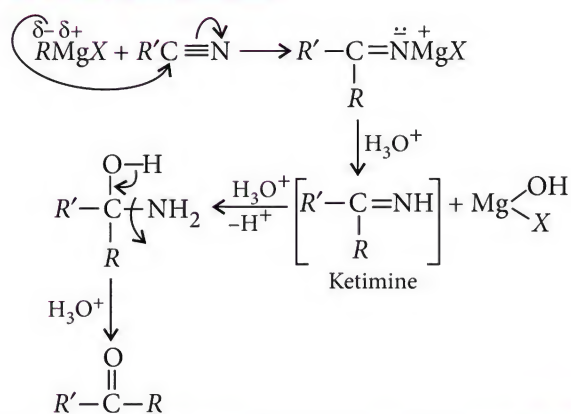
This is not the way the reaction proceeds. The reaction proceeds as shown below :



So,



### ○ Reaction with nitriles



# JEE Advanced

Exam on  
20<sup>th</sup> May

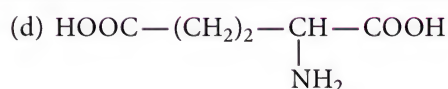
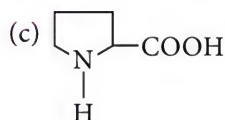
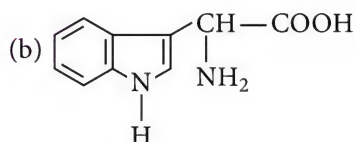
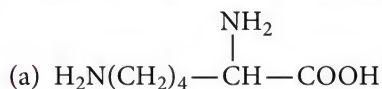
## MODEL TEST PAPER 2018

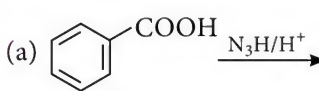
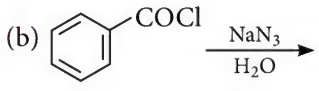
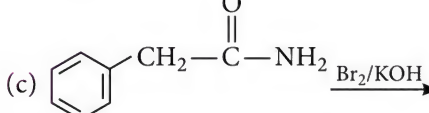
PAPER - 1

### SECTION-I (MAXIMUM MARKS : 28)

This section contains 7 multiple choice questions. Each question has 4 choices (a), (b), (c) and (d), out of which one or more than one answer is/are correct. For each question you will be awarded 4 marks if you have darkened only the bubble corresponding to the correct answer and zero mark if no bubble is darkened. Plus one (+1) mark for darkening a bubble corresponding to each correct option, provided no incorrect option is darkened, minus two (-2) marks will be awarded for incorrect answer in this section.

- Select the correct statement(s).
  - Due to absence of vacant orbital on N atom,  $\text{NCl}_3$  does not undergo hydrolysis.
  - Order of rate of hydrolysis in  $\text{SF}_6$ ,  $\text{SeF}_6$  and  $\text{TeF}_6$  is  $\text{SF}_6 < \text{SeF}_6 < \text{TeF}_6$ .
  - Only proton donor acids are formed as final hydrolysed product of  $\text{SF}_4$ .
  - Lewis acid strength order :  $\text{BF}_3 < \text{BCl}_3 < \text{BBr}_3 < \text{BI}_3$ .
- Among the following which is/are not  $\pi$ -bonded organometallic compound?
  - $\text{K}[\text{PtCl}_3(\eta^2\text{-C}_2\text{H}_4)]$
  - $\text{Fe}(\eta^5\text{-C}_5\text{H}_5)_2$
  - $\text{Cr}(\eta^6\text{-C}_6\text{H}_6)_2$
  - $(\text{CH}_3)_4\text{Sn}$
- Which of the following is/are basic amino acid(s)?



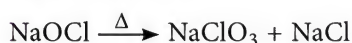
- Consider the following solutions :
  - 1 M aqueous urea solution
  - 1 M aqueous potassium bromide solution
  - 1 M aqueous aluminium phosphate solution
  - 1 M benzoic acid in benzene
 Select correct statement(s) for the above solutions.
  - III is hypertonic of I, II and IV.
  - II is hypotonic of III but hypertonic of I and IV.
  - II and III are isotonic solutions.
  - All are isotonic solutions.
- Which of the following pairs is/are isostructural?
  - $\text{XeF}_2$ ,  $\text{IF}_2^-$
  - $\text{NH}_3$ ,  $\text{BF}_3$
  - $\text{CO}_3^{2-}$ ,  $\text{SO}_3^{2-}$
  - $\text{PCl}_5$ ,  $\text{ICl}_5$
- Which of the following can produce primary amine?
  - 
  - 
  - 
  - $(\text{CH}_3)_3\text{COH} + \text{HCN} \xrightarrow[\text{H}_2\text{O}]{\text{H}^+}$
- Which of the following is/are correct?
  - $\text{H}_2\text{Te} > \text{H}_2\text{Se} > \text{H}_2\text{S} > \text{H}_2\text{O}$  (Acidic character)
  - $\text{NH}_3 > \text{PH}_3 > \text{AsH}_3 > \text{SbH}_3$  (Basic character)
  - $\text{HF} < \text{HBr} < \text{HI} < \text{HCl}$  (Boiling Point)
  - $\text{F} > \text{Cl} > \text{Br} > \text{I}$  (Electron affinity)



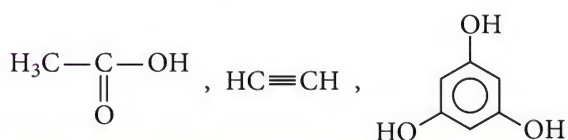
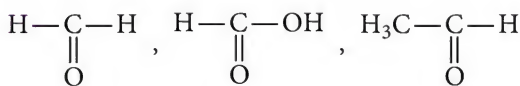
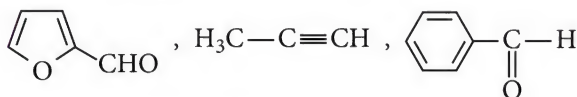
## SECTION-II (MAXIMUM MARKS : 15)

This section contains 5 integer type questions. Answers are to be given in between 0 to 9 (both inclusive) in the form of nearest integer. Each question carries 3 marks if you darken the correct answer and zero mark if no bubble is darkened. No negative mark will be awarded for an incorrectly bubbled answer.

8. How many moles of given compound (NaOCl) are decomposed in the following reaction to form one mole of  $\text{NaClO}_3$ ?



9. The number of P—O—H bonds present in pyrophosphoric acid is
10. Number of neutrons in a parent nucleus 'X' which gives  $^{14}_7\text{N}$  after two successive  $\beta$ -emissions would be
11. An oligosaccharide on hydrolysis produces five monosaccharides. Number of galactose molecules present in the hydrolysis products is
12. Among the following, how many of them will give positive test with Tollens' reagent?



## SECTION-III (MAXIMUM MARKS : 18)

This section contains 6 questions of matching type. There are 2 tables (each having 3 columns and 4 rows). Based on each table, there are 3 questions. Each question has four options (a), (b), (c) and (d). Only one of these four options is correct. For each question you will be awarded 3 marks if you darkened the bubble corresponding to the correct answer and zero mark if no bubble is darkened. In all other cases, minus one (-1) mark will be awarded. Answer Q. 13 to 15 by appropriately matching the information given in the three columns of the following table.

Columns 1, 2 and 3 contain starting materials, reaction conditions, and type of reactions, respectively.

Column 1	Column 2	Column 3
(1) Propene	(A) $\text{NaOH}/\text{X}_2$	(P) Condensation
(2) Aceto-phenone	(B) NBS	(Q) Rearrangement
(3) Benzal-dehyde	(C) $(\text{CH}_3\text{CO})_2\text{O}/\text{CH}_3\text{COOK}$	(R) Substitution
(4) Carbolic acid	(D) $\text{CH}_3\text{COCl}$ in pyridine; Heat	(S) Haloform

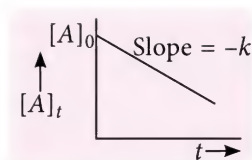
13. The only correct combination in which the reaction proceeds through radical mechanism is  
 (a) (4) (A) (Q) (b) (1) (B) (R)  
 (c) (3) (B) (P) (d) (2) (C) (R)
14. The only correct combination corresponds to Perkin condensation reaction is  
 (a) (3) (C) (P) (b) (4) (C) (Q)  
 (c) (2) (D) (R) (d) (1) (A) (S)
15. For the synthesis of *ortho*- and *para*-hydroxyacetophenone, the only correct combination is  
 (a) (4) (D) (Q)  
 (b) (2) (A) (S)  
 (c) (3) (B) (R)  
 (d) (1) (D) (Q)

Answer Q. 16 to 18 by appropriately matching the information given in the three columns of the following table.

Columns 1, 2 and 3 contain rate constant, effect on rate by changing concentration to  $m$  times, and half-life ( $t_{50}$ ) respectively.

Column 1	Column 2	Column 3
(1) $k = \frac{x}{t}$	(A) $m^2$ times	(P) $\frac{3}{2ka^2}$
(2) $k = \frac{2.303}{t} \log_{10} \left( \frac{a}{a-x} \right)$	(B) no change	(Q) $\frac{1}{ka}$
(3) $k = \frac{2.303}{t(a-b)} \log_{10} \left[ \frac{b(a-x)}{a(b-x)} \right]$	(C) $m^3$ times	(R) $\frac{0.693}{k}$
(4) $k = \frac{1}{2t} \left[ \frac{1}{(a-x)^2} - \frac{1}{a^2} \right]$	(D) $m$ times	(S) $\frac{a}{2k}$

16. For the given graph, the only correct combination is



- (a) (3) (A) (R)  
(b) (2) (D) (S)  
(c) (1) (B) (S) (d) (4) (D) (R)
17. In the following gaseous phase  $n^{\text{th}}$  order reaction,  $A_{(g)} \rightarrow 2B_{(g)} + C_{(g)}$ , initial pressure was found to be 400 mm and it changed to 1000 mm after

20 min having rate constant =  $0.0693 \text{ min}^{-1}$ . The only correct combination for the given information is

- (a) (3) (A) (S) (b) (2) (D) (R)  
(c) (1) (B) (P) (d) (4) (C) (Q)

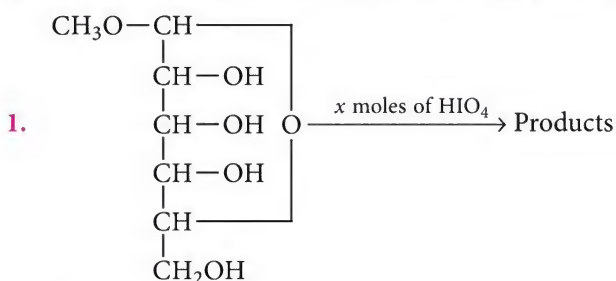
18. The only correct combination for which the order of reaction is equal to the bond order of  $\text{NO}^+$ .

- (a) (1) (A) (R) (b) (3) (B) (Q)  
(c) (4) (C) (P) (d) (2) (D) (S)

## PAPER - 2

### SECTION-I (MAXIMUM MARKS : 21)

This section contains 7 multiple choice questions. Each question has 4 choices (a), (b), (c) and (d), out of which one is correct. For each question you will be awarded 3 marks if you darkened the bubble corresponding to the correct answer and zero mark if no bubble is darkened. In all other cases, minus one (-1) mark will be awarded.



Value of  $x$  is

- (a) 2 (b) 3 (c) 4 (d) 5
2. Heat of formation of  $\text{H}_2\text{O}_{(g)}$  at 1 atm and  $25^\circ\text{C}$  is  $-243 \text{ kJ}$ .  $\Delta E$  for the reaction,  $\text{H}_{2(g)} + \frac{1}{2} \text{O}_{2(g)} \rightarrow \text{H}_2\text{O}_{(g)}$  at  $25^\circ\text{C}$  is
- (a)  $241.8 \text{ kJ}$  (b)  $-241.8 \text{ kJ}$   
(c)  $-243 \text{ kJ}$  (d)  $243 \text{ kJ}$
3. At moderate pressure, the van der Waals' equation is written as  $\left(P + \frac{a}{V^2}\right)V = RT$ . The compressibility factor is then equal to
- (a)  $\left(1 - \frac{a}{RTV}\right)$  (b)  $\left(1 - \frac{RTV}{a}\right)$   
(c)  $\left(1 + \frac{a}{RTV}\right)$  (d)  $\left(1 + \frac{RTV}{a}\right)$
4. An organic compound 'P' on analysis gives 60.4% C, 13.3% H and 26.30% O. 'P' reacts with Na metal liberates  $\text{H}_{2(g)}$  and on mild oxidation gives

'Q' which gives positive iodoform test. The organic compound 'P' can be  $\text{C}_x\text{H}_y\text{O}_z$ . What is the value of  $(y - x)$ ?

- (a) 5 (b) 6  
(c) 7 (d) 4

5. For the square planar complex  $[\text{Pt}(\text{NH}_3)(\text{NH}_2\text{OH})(py)(\text{CH}_3)]^+$ ,

how many geometrical isomers are possible?

- (a) 3 (b) 1  
(c) 2 (d) 4

6. Washing soda ( $\text{Na}_2\text{CO}_3 \cdot 10\text{H}_2\text{O}$ ) is widely used in softening of hard water. If 1 L of hard water requires 0.0143 g of washing soda, the hardness of  $\text{CaCO}_3$  in ppm is

- (a) 2 (b) 5  
(c) 10 (d) 14

7.  $\text{O}_2$  molecule dissociates into one normal oxygen atom (O) and one energetic oxygen atom ( $\text{O}^*$ ). ( $\text{O}^*$ ) has 1.967 eV more energy than (O) and normal dissociation energy of  $\text{O}_2$  is  $498 \text{ kJ mol}^{-1}$ . The maximum wavelength (in m) effective for the photochemical dissociation can be expressed in scientific notation as  $y \times 10^x$ . The value of  $y$  approximately is [ $1 \text{ eV} = 1.6 \times 10^{-19} \text{ Joule}$ ]

- (a) 6 (b) 8  
(c) 2 (d) 4

### MPP-10 CLASS XII ANSWER KEY

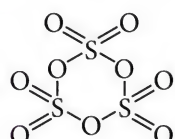
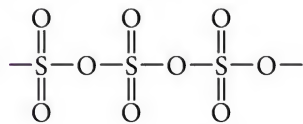
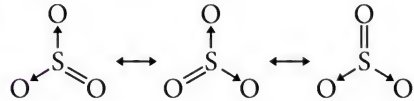
- |             |             |           |         |           |
|-------------|-------------|-----------|---------|-----------|
| 1. (b)      | 2. (d)      | 3. (d)    | 4. (d)  | 5. (d)    |
| 6. (d)      | 7. (a)      | 8. (a)    | 9. (a)  | 10. (d)   |
| 11. (d)     | 12. (c)     | 13. (b)   | 14. (c) | 15. (c)   |
| 16. (b)     | 17. (b)     | 18. (d)   | 19. (c) | 20. (a,b) |
| 21. (b,c,d) | 22. (a,b,c) | 23. (a,c) | 24. (3) | 25. (5)   |
| 26. (6)     | 27. (b)     | 28. (c)   | 29. (a) | 30. (c)   |



## SECTION-II (MAXIMUM MARKS : 28)

This section contains 7 multiple choice questions. Each question has four choices (a), (b), (c) and (d) out of which one or more than one is/are correct. For each question, you will be awarded 4 marks if you darken all the bubble(s) corresponding to the correct answer(s) and zero mark if no bubble is darkened. Plus one (+1) mark for darkening a bubble corresponding to each correct option, provided no incorrect option is darkened, minus two (–2) marks will be awarded for incorrect answers in this section.

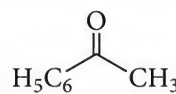
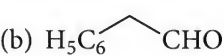
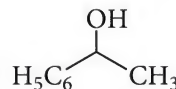
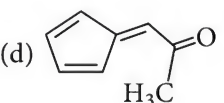
8. Nitrogen(I) oxide can be produced by  
 (a) thermal decomposition of ammonium nitrate  
 (b) disproportionation of  $N_2O_4$   
 (c) thermal decomposition of ammonium nitrite  
 (d) reaction of hydroxylamine and nitrous acid.
9. Which of the following ores can be concentrated by froth floatation process?  
 (a) Zinc blende (b) Copper pyrites  
 (c) Argentite (d) Horn silver
10. In solid state,  $SO_3$  may have structure(s)

- (a) 
- (b) 
- (c) 
- (d) all of these.

11. NiO is to be reduced to nickel metal in an industrial process by use of the following reaction :  

$$NiO_{(s)} + CO_{(g)} \rightleftharpoons Ni_{(s)} + CO_{2(g)}$$
 At 1600 K, the equilibrium constant for the reaction is  $K_p = 6.0 \times 10^2$ . If CO pressure of 150 torr is to be employed in the furnace and total pressure never exceeds 760 torr, will reduction occur?  
 (a) No (b) Yes  
 (c) Cannot be said (d) May or may not
12. Compound (X) having molecular formula,  $C_8H_8O$  is water insoluble and gives yellow ppt. with  $I_2/NaOH$ . It reacts with  $H_2N-OH$  in the presence of  $NH_4Cl/NH_4OH$  to give two geometrical isomers,

which do not undergo dehydration but can go for rearrangement with acids. Compound (X) can be

- (a)  (b) 
- (c)  (d) 

13. If 10 grams of a fairly dilute solution of cupric sulphate is electrolysed using 0.01 F of electricity using platinum electrode then  
 (a) mass of resulting solution is 0.3175 g  
 (b) mass of copper deposited is 0.3175 g  
 (c) mass of resulting solution is 9.6025 g  
 (d) total weight loss from solution is 0.3975 g
14. Pick out correct statement(s).  
 (a) In  $PCl_5$ , P is  $sp^3d$  hybridized and has trigonal bipyramidal geometry.  
 (b)  $PCl_5$  hydrolyses to form phosphoric acid.  
 (c)  $PCl_5$  acts as Lewis acid.  
 (d) In  $PCl_5$ , the axial chlorine atoms are closer to central P atom than equatorial chlorine atoms.

**SECTION-III (MAXIMUM MARKS : 12)**

This section contains 2 paragraphs each describing theory, experiment, data, etc. Four questions relate to two paragraphs with two questions on each paragraph. Each question pertaining to a particular passage should have only one correct answer among the four choices (a), (b), (c) and (d). For each question you will be awarded 3 marks if you darkened the bubble corresponding to the correct answer and zero mark if no bubble is darkened. No negative marks will be awarded for an incorrect answer in this section.

**Paragraph for Questions 15 and 16**

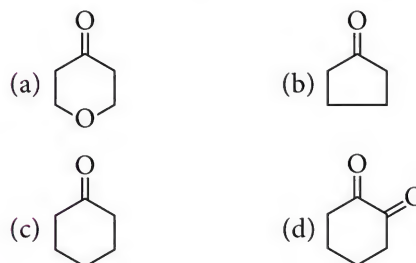
According to C.F.T., attraction between the central metal ion and ligands in a complex is purely electrostatic. The transition metal which forms the central atom in the complex is regarded as a positive ion. It is surrounded by negative ligands or neutral molecules which have lone pairs of electrons. If the ligand is a neutral molecule such as  $\text{NH}_3$ , the negative end of the dipole in the molecule is directed towards the metal cation. The electrons on the central metal ion are under repulsive forces from those on the ligands. Thus, the electrons occupy the  $d$ -orbitals remain away from the direction of approach of ligands.

15. The crystal field splitting order for  $\text{Cr}^{3+}$  cation in octahedral field for ligands  $\text{I}^-$ ,  $\text{NH}_3$ ,  $\text{H}_2\text{O}$ ,  $\text{CN}^-$  is  
 (a)  $\text{I}^- < \text{H}_2\text{O} < \text{NH}_3 < \text{CN}^-$   
 (b)  $\text{I}^- < \text{NH}_3 < \text{H}_2\text{O} < \text{CN}^-$   
 (c)  $\text{H}_2\text{O} < \text{I}^- < \text{NH}_3 < \text{CN}^-$   
 (d)  $\text{NH}_3 < \text{I}^- < \text{H}_2\text{O} < \text{CN}^-$
16. Choose the incorrect option.  
 (a) A solution of  $[\text{Ni}(\text{H}_2\text{O})_6]^{2+}$  is green but a solution of  $[\text{Ni}(\text{CN})_4]^{2-}$  is colourless.  
 (b)  $[\text{Fe}(\text{CN})_6]^{4-}$  and  $[\text{Fe}(\text{H}_2\text{O})_6]^{3+}$  are of different colours in dilute solutions.  
 (c) Aqueous copper sulphate (blue in colour) gives a bright green solution with aqueous potassium chloride.  
 (d) Precipitate of copper sulphide is obtained when  $\text{H}_2\text{S}_{(\text{g})}$  is passed through the  $[\text{Cu}(\text{CN})_4]^{2-}$  solution.

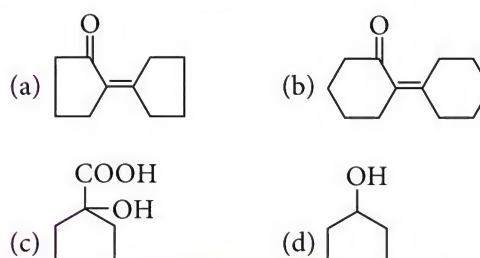
**Paragraph for Questions 17 and 18**

An organic compound 'A' on acid hydrolysis produces B, an amino acid. 'B' on treating with  $\text{HNO}_2$  gives 'C'. 'C' on heating with conc.  $\text{H}_2\text{SO}_4$  produces a lactone 'D'. 'A' can also be synthesised by the reaction of cyclopentanone with  $\text{NH}_2\text{OH}$  followed by treatment with conc.  $\text{H}_2\text{SO}_4$ .

17. Compound 'D' can be obtained by peroxidation of compound 'X'. Where 'X' is



18.  $\text{X} \xrightarrow{\text{OH}^-/\Delta} \text{Y}$ . Compound 'Y' can be

**ANSWER KEY****PAPER - 1**

1. (b,c,d) 2. (d) 3. (a) 4. (c) 5. (a)  
 6. (a,b,c,d) 7. (a,b) 8. (3) 9. (4)  
 10. (9) 11. (3) 12. (7) 13. (b) 14. (a)  
 15. (a) 16. (c) 17. (b) 18. (c)

**PAPER - 2**

1. (a) 2. (b) 3. (a) 4. (a) 5. (a)  
 6. (b) 7. (c) 8. (a,d) 9. (a,b,c) 10. (a,b)  
 11. (b) 12. (a,d) 13. (b,c,d) 14. (a,b,c) 15. (a)  
 16. (d) 17. (b) 18. (a)

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**Solution Senders of Chemistry Musing****Set - 54**

- Anshuman Pan, West Bengal
- Sumit Mahajan, Odisha

**Set - 53**

- Abhay Singh, Punjab





# ADVANCED CHEMISTRY BLOC

## (REDUCING AND OXIDISING AGENTS)

Mk C.R ay,O il sh

### REDUCING AGENTS AND THEIR BEHAVIOUR

#### Reagent Wise :

- 1.  $\text{LiAlH}_4$  :** Lithium aluminium hydride is a very active reducing agent. It reduces carboxylic acid, acid chloride, acid anhydride and aldehyde to primary alcohol, ketones to secondary alcohols and amides to primary amines ( $\text{RCONH}_2$  to  $\text{RCH}_2\text{NH}_2$ ). Nitro compounds, if aromatic are usually reduced to azo compounds, and if aliphatic to primary amines. The  $\text{C}=\text{C}$  bond is usually not affected. Primary and secondary alkyl halides are converted to respective alkanes but the tertiary halides become alkenes by the action of  $\text{LiAlH}_4$ .
- 2.  $\text{B}_2\text{H}_6$  :** It reduces aldehydes, ketones and carboxylic acids to alcohols. It also reduces amide to amine ( $\text{RCONH}_2$  to  $\text{RCH}_2\text{NH}_2$ ). It slowly reduces carboxylic ester to alcohol. Its rapidity of reaction with carboxylic acid and slow reactivity towards esters allows it to chemoselectively reduce carboxylic acid in presence of ester. It can reduce  $\text{C}=\text{C}$  to  $\text{C}-\text{C}$  and epoxide to alcohol. However, it fails to reduce  $-\text{COCl}$ ,  $-\text{CN}$ ,  $-\text{NO}_2$ ,  $\text{RX}$ ,  $\text{ArX}$ .
- 3.  $\text{NaBH}_4$  :** This is a mild reducing agent. It can reduce aldehydes and ketones to alcohols. Acyl chloride and epoxides are also reduced to alcohols. Alkyl halides become alkanes. Primary and secondary alkyl iodides, primary bromides, benzyl and allyl chlorides are smoothly reduced by  $\text{NaBH}_4$ . However, it fails in the reduction of the following:  $-\text{NO}_2$ ,  $-\text{COOH}$ ,  $-\text{COOR}$ ,  $-\text{CN}$  (generally fails)

#### Functional Group Wise :

- 1. Reduction of  $-\text{CO}-$  to  $-\text{CH}_2-$** 
    - $\text{HI/Red P}$  ( $\text{Zn-Hg/HCl}$ )
    - Clemmensen reduction
    - Wolff—Kishner reduction ( $\text{NH}_2\text{NH}_2/\text{KOH}$ )
  - 2. Reduction of  $-\text{CO}-$  to  $-\text{CHOH}-$  (both in aldehyde and in ketone)**
    - $\text{H}_2/\text{Ni}$
    - $\text{H}_2/\text{Pd}$  ( $\text{Pd}$  is not very active for aliphatic carbonyl compounds but effective for aromatic carbonyl compounds)
    - $\text{LiAlH}_4$
    - $\text{NaBH}_4$
    - $\text{B}_2\text{H}_6$
    - $\text{Na/alcohol}$
  - 3. Reduction of  $-\text{COOH}$  to  $-\text{CH}_2\text{OH}$** 
    - $\text{LiAlH}_4$
    - $\text{H}_2/\text{Ruthenium dioxide}$
    - $\text{H}_2/\text{Ru-C}$
  - 4. Reduction of  $-\text{COOR}$  to  $-\text{CH}_2\text{OH}$** 
    - $\text{LiAlH}_4$
    - $\text{B}_2\text{H}_6$  (slow)
    - $\text{H}_2/\text{copper chromite}$
    - Ester is reduced to aldehyde by DIBAL-H
  - 5. Reduction of  $\text{C}=\text{C}$  to  $\text{CH}-\text{CH}$** 
    - $\text{H}_2/\text{Ni}$  (*Syn*)
    - $\text{B}_2\text{H}_6$  followed by acetic acid (*Syn*)
    - $\text{H}_2/\text{Wilkinson's catalyst}$  (Homogeneous hydrogenation)
- Note :** Though both  $\text{>C}=\text{O}$  and  $\text{C}=\text{C}$  double bond can be reduced by catalytic hydrogenation but double bond is more reactive. This helps us to selectively reduce  $\text{C}=\text{C}$  when it is in conjugation with a carbonyl group by using  $\text{H}_2/\text{Pd-C}$ .
- 6. Reduction of  $\text{C}\equiv\text{C}$  to  $\text{CH}=\text{CH}$** 
    - $\text{H}_2/\text{Ni}_2\text{B}$  (alternative name P-2)
    - $\text{Na/NH}_3(l)$  (only for non-terminal alkyne)
    - $\text{H}_2/\text{Pd-CaCO}_3$  (Lindlar catalyst)

(Lindlar and P-2 cause *syn*-addition but  $\text{Na/NH}_3(l)$  causes *anti*-addition.)

## 7. $RX$ to $RH$

- $LiAlH_4$  (For  $1^\circ$  and  $2^\circ$  alkyl halides)
- $NaBH_4$
- $Bu_3SnH$  (free radical reaction, useful particularly for  $-Br$ )
- $Zn$ /acetic acid

## 8. $RNO_2$ to $RNH_2$

- $H_2/Ni$  or  $Pt$  or  $Pd$
- $Sn/HCl$
- $SnCl_2/HCl$  (is particularly useful for  $ArNO_2$ )
- $LiAlH_4$

## 9. $ArNO_2$

- $LiAlH_4$  reduces  $ArNO_2$  to  $Ar-N=N-Ar$
- $Fe$ /steam reduces  $ArNO_2$  to  $ArNO$
- $SnCl_2/HCl$  reduces  $ArNO_2$  to  $ArNH_2$
- $H_2/Ni$  reduces  $ArNO_2$  to  $ArNH_2$
- $Zn$  dust/aq.  $NaOH$  reduces  $ArNO_2$  to  $ArNH-NHAr$
- $Na-Hg$ ,  $Zn/NaOH/MeOH$  reduce  $ArNO_2$  to  $Ar-N=N-Ar$
- Glucose/ $NaOH$  or  $Na_3AsO_3/NaOH$  convert it to azoxybenzene.
- Electrolytic reduction in weakly acidic medium converts it to aniline.
- Electrolytic reduction in strong acidic medium converts it to  $p$ -aminophenol.

## 10. $RN_3$ to $RNH_2$

- $H_2/Ni$

## 11. $RCN$

- $LiAlH_4$  converts it to amine.
- $Na$ /alcohol converts it to amine.
- $H_2/Ni$  converts it to amine.
- $DIBAL-H$  converts it to aldehyde.

## Functional Group Wise :

### 1. $-CH_2OH$ to $-CHO$

- $PCC$
- $PDC$
- $CrO_3$  in pyridine (Collins reagent)
- $CrO_3$  in pyridine in  $CH_2Cl_2$  solvent (Sarret reagent)
- Solution of  $CrO_3$  in dilute sulphuric acid and aqueous acetone (Jones reagent).
- $Cu$ /heat

All these reagents convert primary alcohols to aldehydes without causing over oxidation but Jones reagent is particularly useful for oxidation of allylic and benzylic alcohols to respective aldehydes only at  $0^\circ C$ .

All the above mentioned reagents can also oxidise secondary alcohols to ketones.  $Cu$ /heat converts tertiary alcohols to alkenes.

### 2. $-CH_2OH$ to $-COOH$

- $MnO_4^-/H^+$
- $Cr_2O_7^{2-}/H^+$
- Dilute  $HNO_3$

### 3. $C=C$ to epoxide

- Peracid like  $m$ -CPBA
- $Ag/O_2$

### 4. $C=C$ to diol

- Dilute cold alkaline  $KMnO_4$  (Baeyer's reagent) (*syn*-hydroxylation)
- $OsO_4$  followed by aqueous  $Na_2SO_3$  hydrolysis (*syn*-hydroxylation)
- $m$ -CPBA followed by acid hydrolysis (*anti*-hydroxylation)

### 5. $C=C$ to carbonyl compounds, acids and $CO_2$ (Oxidative cleavage)

- Ozonolysis
- Lemieux reagent,  $NaIO_4/KMnO_4$  (formaldehyde is usually obtained from a terminal alkene)
- Hot and strong alkaline or acidic  $KMnO_4$

## OXIDISING AGENTS AND THEIR BEHAVIOUR

### Reagent Wise :

1.  $MnO_2$  : Selectively oxidises allylic and benzylic primary and secondary alcohols to respective carbonyl compounds.
2.  $SeO_2$  : Introduces one carbonyl next to the existing one and introduces  $-OH$  group at the allylic position and benzylic position.
3.  $NBS$  : Allylic brominating agent

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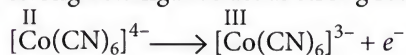
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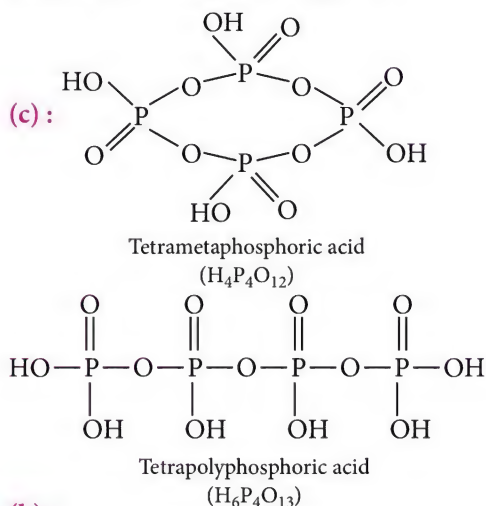
# CHEMISTRY MUSING

## SOLUTION SET 54

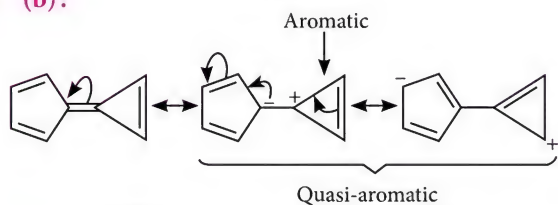
1. (a): All the complexes of  $\text{Co}^{2+} : [\text{Ar}]3d^7$  with six strong field ligands act as strong reducing agents.



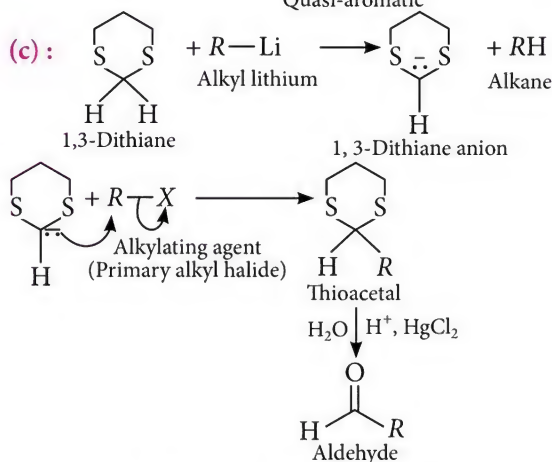
2. (c):



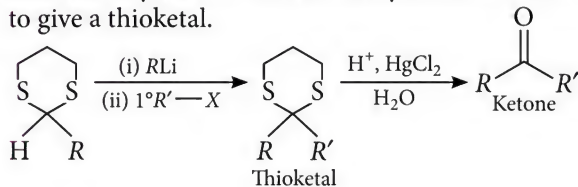
3. (b):



4. (c):



Alternatively, thioacetal can be alkylated once more to give a thioketal.

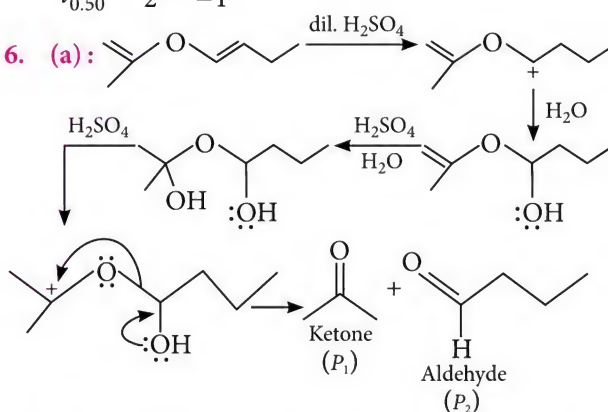


5. (c):  $kt = \frac{1}{n-1} \left[ \frac{1}{[A]_t^{n-1}} - \frac{1}{[A]_0^{n-1}} \right]$

$$kt_{0.50} = \frac{1}{n-1} \left[ \frac{2^{n-1}-1}{[A]_0^{n-1}} \right], \quad kt_{0.875} = \frac{1}{n-1} \left[ \frac{8^{n-1}-1}{[A]_0^{n-1}} \right]$$

$$\frac{t_{0.875}}{t_{0.50}} = \frac{8^{n-1}-1}{2^{n-1}-1}$$

6. (a):



7. (c): On ozonolysis,  $\alpha$ -farnesene gives acetone.

8. (d)

9. (5):  $\lambda = \frac{h}{\sqrt{2mK.E.}}$

$$\frac{\lambda_{\text{He}}}{\lambda_{\text{Ne}}} = \frac{m_{\text{Ne}}(K.E.)_{\text{Ne}}}{m_{\text{He}}(K.E.)_{\text{He}}} \quad \dots(i)$$

$$\frac{m_{\text{Ne}}}{m_{\text{He}}} = \frac{20}{4} = 5 \quad \dots(ii)$$

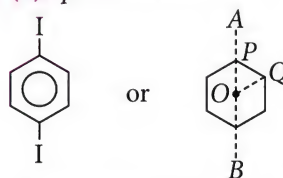
$$K.E. \propto T$$

$$\frac{(K.E.)_{\text{Ne}}}{(K.E.)_{\text{He}}} = \frac{727+273}{-73+273} = \frac{1000}{200} = 5 \quad \dots(iii)$$

Now, from eqns. (i), (ii) and (iii), we get

$$\frac{\lambda_{\text{He}}}{\lambda_{\text{Ne}}} = 5$$

10. (7):  $p$ -Diiodobenzene:



$$\therefore AB = OA + OB = 2OA$$

$$= 2(OP + PA)$$

$$= 2 \times (PQ + PA) (\because OP = PQ; \Delta OPQ \text{ is equilateral})$$

$$= 2(PQ + \text{covalent radius of C} + \text{covalent radius of I})$$

$$= 2 \times (1.40 + 0.77 + 1.33) = 7.0 \text{ \AA}$$



Get well-prepared for exams with quick revision of important formulae of physical chemistry.

#### Some Basic Concepts of Chemistry

- Percentage yield =  $\frac{\text{Actual yield}}{\text{Theoretical yield}} \times 100$
- Atomic mass =  $\frac{\text{Mass of one atom of the element}}{\frac{1}{12} \times \text{Mass of an atom of C-12}}$   
= Eq. mass  $\times$  Valency
- Atomic mass =  $\frac{\text{Molecular mass}}{\text{Atomicity}} = \frac{\text{Specific heat (cal/g)}}{2 \times \text{Vapour density}}$
- Molecular mass =  $2 \times \text{Vapour density}$
- Number of gram atoms =  $\frac{\text{Gram atomic mass (GAM)}}{\text{Gram atomic mass (GAM)}}$
- Number of gram molecules =  $\frac{\text{Gram molecular mass (GMM)}}{\text{Gram molecular mass (GMM)}}$
- Number of gram equivalents =  $\frac{\text{Gram equivalent mass (GEM)}}{\text{Gram equivalent mass (GEM)}}$
- Equivalent mass of an element =  $\frac{\text{Atomic mass}}{\text{Valency}}$
- Equivalent mass of an acid =  $\frac{\text{Molecular mass of acid}}{\text{Basicity}}$
- Equivalent mass of a base =  $\frac{\text{Molecular mass of base}}{\text{Acidity}}$
- Percentage composition =  $\frac{\text{Mass of the element}}{\text{Molar mass of compound}} \times 100$
- Mass % =  $\frac{\text{Mass of solute}}{\text{Mass of solution}} \times 100$
- Molarity (M) =  $\frac{W_B \times 1000}{M_B \times V \text{ (in mL)}}$
- Normality (N) =  $\frac{EM_B \times V \text{ (in mL)}}{W_B \times 1000}$
- Molality (m) =  $\frac{M_B \times W_A \text{ (in g)}}{M_B \times W_A + W_B}$   
where,  $W_B$  = Mass of solute,  $M_B$  = Molecular mass of solute  
 $W_A$  = Mass of solvent
- Mole fraction,  $x_B = \frac{n_B}{n_A + n_B}$  and  $x_A = \frac{n_A}{n_A + n_B}$
- $M_1 V_1 / n_1 = M_2 V_2 / n_2$  or  $N_1 V_1 = N_2 V_2$
- $M_3 (V_1 + V_2) = M_1 V_1 + M_2 V_2$
- $\frac{1}{x_B} = 1 - \frac{M_B}{M_A} \times \frac{1000d}{M_A \times M} = 1 + \frac{1000}{m \times M_A}$
- Number of moles = Molarity  $\times$  Volume
- Number of equivalents = Normality  $\times$  Volume
- Molecular formula =  $n \times$  Empirical formula  
Molecular formula mass
- $n = \frac{\text{Empirical formula mass}}$

#### Structure of Atom

- Radius of nucleus ( $R$ ) =  $R_0 A^{1/3}$   
 $R_0 = \text{Constant} (= 1.33 \times 10^{-13} \text{ cm})$   
 $A = \text{Mass number of atom}$
- $\bar{v} = \frac{1}{\lambda} = \frac{v}{c}$ ;  $E = \frac{hc}{\lambda} = h\nu = \frac{1}{h\nu_0 + \frac{1}{2}}$
- $\bar{v} = 109.677 \left( \frac{1}{n_1^2} - \frac{1}{n_2^2} \right) \text{ cm}^{-1}$ ;  $v = 3.29 \times 10^{15} \left( \frac{1}{n_1^2} - \frac{1}{n_2^2} \right) \text{ s}^{-1}$
- $mvr = \frac{nh}{2\pi}$ ;  $r_n = \frac{n^2 a_0}{Z}$  or  $\frac{52.9n^2}{Z} \text{ pm}$
- $E_n = -R_H \left( \frac{Z^2}{n^2} \right) = -2.18 \times 10^{-18} \left( \frac{Z^2}{n^2} \right) \text{ J/atom}$   
or  $-\frac{Z^2}{n^2} \times 1312 \text{ kJ/mol}$  or  $-\frac{Z^2}{n^2} \times 13.6 \text{ eV/atom}$
- $v_n = \frac{2.19 \times 10^6 \times Z}{n} \text{ m s}^{-1}$
- $\Delta E = R_H \left( \frac{1}{n_1^2} - \frac{1}{n_2^2} \right) = 2.18 \times 10^{-18} \left( \frac{1}{n_1^2} - \frac{1}{n_2^2} \right)$
- $\lambda = \frac{h}{mv} = \frac{h}{p} = \frac{h}{\sqrt{2mE_k}} = \frac{h}{\sqrt{2mqV}}$
- $\Delta x \cdot \Delta p \geq \frac{h}{4\pi}$  or  $\Delta x \cdot \Delta v \geq \frac{h}{4\pi m}$
- Schrödinger wave equation:
- $\nabla^2 \psi + \frac{8\pi^2 m}{h^2} (E - V) \psi = 0$ ;  $V = \text{Laplacian operator}$
- Maximum no. of spectral lines produced when an electron jumps from  $n \rightarrow 1 = \frac{n(n-1)}{2}$
- No. of lines in the spectrum when an electron returns from  $n_2 \rightarrow n_1 = \frac{(n_2 - n_1)(n_2 - n_1 + 1)}{2}$
- $I.E. = E_\infty - E_n = 2.18 \times 10^{-18} \times \frac{Z^2}{n^2} \text{ J/atom}$   
or  $13.6 \times \frac{Z^2}{n^2} \text{ eV/atom}$
- Orbital angular momentum =  $\sqrt{l(l+1)} \frac{h}{2\pi}$
- Magnetic moment =  $\sqrt{n(n+2)} \text{ B.M.}$
- Spin angular momentum =  $\sqrt{s(s+1)} \frac{h}{2\pi}$
- Spin multiplicity =  $2S + 1$ ;  
 $S = \text{Sum of spin quantum numbers.}$
- Radial nodes =  $n - l - 1$ ; Angular nodes =  $l$
- Total no. of nodes =  $n - 1$

Get well-prepared for exams with quick revision of important concepts of inorganic chemistry.

#### General Principles and Processes of Isolation of Elements

- Main steps involved in extraction of metals:**
  - Concentration of the ore:** *Hydraulic separation* (based on difference in densities of ore) : for oxide ores; *Flath floatation* (based on preferential wetting of ore (by oil) and gangue (by water)) : for sulphide ores; *Electromagnetic separation* (based on difference in magnetic properties) : for magnetic impurities/ores; *Leaching*: chemical method.
  - Conversion of ore to oxide:** *Calcination* (limited supply or in absence of air) : for carbonates and hydrated oxides; *Roasting* (in excess of air) : for sulphide ores.
  - Reduction of oxide to free metal:** *Smelting* : Reduction with carbon; *Alumino-thermite process*: Reduction with Aluminium; *Auto-reduction* : for less electropositive metals; *Electrometallurgy*: Electrolysis of fused oxide.
  - Refining of crude metals:** *Liquation* : for metals having low boiling points; *Distillation* : for volatile metals; *Poling* : for metals having own oxides as impurities; *Electrorefining* : for Cu, Ag, Au, Ni, Cr, Al; *Zone refining* : for Si, Ge, Ga; *van-Arkel method*: for Ti and Zr; *Chromatography*: for elements available in minute quantities (coloured pigments); *Cupellation* : used when impurities of metals present, forms volatile oxides.

#### d- and f-Block Elements

- d-block elements:**  $(n-1)d^1-10, ns^2$ 
  - 3d series:  $_{21}\text{Sc} - _{30}\text{Zn}$ ; 4d series:  $_{39}\text{Y} - _{48}\text{Cd}$
  - 5d series:  $_{57}\text{La}, _{72}\text{Hf} - _{80}\text{Hg}$ ; 6d series:  $_{89}\text{Ac}, _{104}\text{Rf} - _{112}\text{Cn}$
  - Acidic character:  $\text{MnO} < \text{Mn}_2\text{O}_3 < \text{Mn}_2\text{O}_4 < \text{Mn}_2\text{O}_7$
  - Ionic character:  $\text{MnO} > \text{Mn}_2\text{O}_3 > \text{Mn}_2\text{O}_4 > \text{Mn}_2\text{O}_7$
- Colors:**

Basic	Amphoteric	Acidic
$\text{Ti}^{3+}$ Purple	$\text{V}^{3+}$ Green	$\text{Mn}^{2+}$ Pale pink
$\text{Cr}^{3+}$ Green	$\text{Fe}^{3+}$ Yellow	$\text{Co}^{2+}$ Pink
$\text{Ni}^{2+}$ Green	$\text{Cu}^{2+}$ Blue	$\text{Ni}^{2+}$ Green
- f-block elements:**  $(n-2)f^{1-14}(n-1)d^0-1, ns^2$ 
  - Lanthanides or 4f-series:  $\text{Ce}(Z=58)$  to  $\text{Lu}(Z=71)$
  - Actinides or 5f-series:  $\text{Th}(Z=90)$  to  $\text{Lr}(Z=103)$
  - $\text{La}(\text{OH})_3$  to  $\text{Lu}(\text{OH})_3$ : Basicity decreases
  - $\text{La}^{3+}(4f^0)$ ,  $\text{Gd}^{3+}(4f^7)$ ,  $\text{Lu}^{3+}(4f^{14}) \rightarrow$  Colourless.
- Colors:**

$\text{Pr}^{3+}(4f^2)$ Green	$\text{Tm}^{3+}(4f^{12})$ Green	$\text{Na}^{3+}(4f^3)$ Pink	$\text{Sm}^{3+}(4f^5)$ Yellow
------------------------------	---------------------------------	-----------------------------	-------------------------------
- $\text{Ce}^{3+}(4f^1)$  and  $\text{Yb}^{3+}(4f^{13}) \rightarrow$  Colourless despite of having unpaired electrons (exceptions).

#### The p-Block Elements

- Group 15 (Nitrogen family):**  $ns^2 np^3$ 
  - Bond angle, Thermal stability and Basic strength:  $\text{NH}_3 > \text{PH}_3 > \text{AsH}_3 > \text{SbH}_3 > \text{BiH}_3$
  - Boiling point:  $\text{PH}_3 < \text{AsH}_3 < \text{NH}_3 < \text{SbH}_3 < \text{BiH}_3$
  - Melting point:  $\text{PH}_3 < \text{AsH}_3 < \text{SbH}_3 < \text{NH}_3$
  - Reducing nature:  $\text{NH}_3 < \text{PH}_3 < \text{AsH}_3 < \text{SbH}_3 < \text{BiH}_3$
  - Bond angle:  $\text{PF}_3 < \text{PCl}_3 < \text{PBr}_3 < \text{PI}_3$
  - Lewis acid strength:  $\text{PCl}_3 > \text{AsCl}_3 > \text{SbCl}_3$ ;
- Group 16 (Oxygen family):**  $ns^2 np^4$ 
  - Bond angle and Thermal stability:  $\text{H}_2\text{O} > \text{H}_2\text{S} > \text{H}_2\text{Se} > \text{H}_2\text{Te}$
  - Volatility:  $\text{H}_2\text{S} > \text{H}_2\text{Se} > \text{H}_2\text{Te} > \text{H}_2\text{O}$
  - Acidic strength and Reducing nature:  $\text{H}_2\text{O} < \text{H}_2\text{S} < \text{H}_2\text{Se} < \text{H}_2\text{Te}$
  - Stability:  $\text{SF}_6 > \text{SeF}_6 > \text{TeF}_6$
- Group 17 (Halogens family):**  $ns^2 np^5$ 
  - Oxidising power:  $\text{F}_2 > \text{Cl}_2 > \text{Br}_2 > \text{I}_2$
  - Boiling point:  $\text{HCl} < \text{HBr} < \text{HI} < \text{HF}$
  - Melting point:  $\text{HCl} < \text{HBr} < \text{HF} < \text{HI}$
  - Dipole moment and Thermal stability:  $\text{HF} > \text{HCl} > \text{HBr} > \text{HI}$
  - Bond length, Acidic strength and Reducing nature:  $\text{HF} < \text{HCl} < \text{HBr} < \text{HI}$
  - Acidic strength:  $\text{HClO} < \text{HClO}_2 < \text{HClO}_3 < \text{HClO}_4$
  - Oxidising power:  $\text{HClO} > \text{HClO}_2 > \text{HClO}_3 > \text{HClO}_4$
- Group 18 (Noble gases):**  $ns^2 np^6$ 
  - Melting and boiling points, Ease of liquefaction, Solubility, Adsorption and Polarisability:  $\text{He} < \text{Ne} < \text{Ar} < \text{Kr} < \text{Xe} < \text{Rn}$
  - Thermal conductivity:  $\text{He} > \text{Ne} > \text{Ar} > \text{Kr} > \text{Xe}$

#### Coordination Compounds



- EAN Rule (Effective Atomic Number):**  
 $\text{EAN} = Z_{(\text{Metal atom})} - \text{Oxidation number of metal} + 2 \times \text{Coordination number}$
- Spectrochemical series:** (Increasing order of CFSE)  
 $\text{I}^- < \text{Br}^- < \text{SCN}^- < \text{Cl}^- < \text{F}^- < \text{OH}^- < \text{C}_2\text{O}_4^{2-} < \text{O}^{2-} < \text{H}_2\text{O} < \text{NCS}^- < \text{EDTA}^{4-} < \text{NH}_3 < \text{en} < \text{NO}_2^- < \text{CN}^- < \text{CO}$
- $\mu = \sqrt{n(n+2)} \text{ B.M.}$
- If  $\Delta_o < P$ , high spin complex, if  $\Delta_o > P$ , low spin complex.
- Where,  $x = \text{no. of } e^- \text{ in } t_{2g} \text{ orbitals}$ ,  $y = \text{no. of } e^- \text{ in } e_g \text{ orbitals}$ .



# NEET | JEE

## ESSENTIALS

Class  
XI

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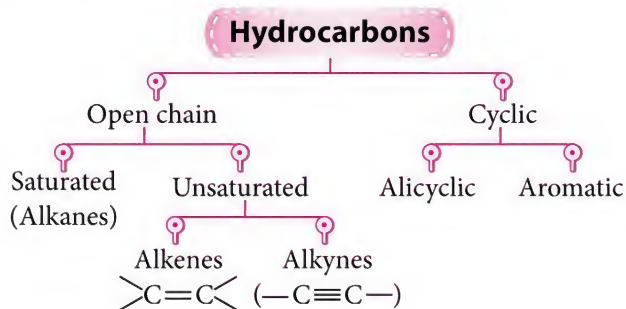
## Unit 8

## Hydrocarbons | Environmental Chemistry

### HYDROCARBONS

#### INTRODUCTION

Organic compounds composed of only carbon and hydrogen are known as hydrocarbons.



#### ALKANES

- General formula :  $C_nH_{2n+2}$
- Due to inertness known as paraffins.
- Only C – C and C – H single bonds are present.
- All carbons are  $sp^3$  hybridised.

#### Isomerism

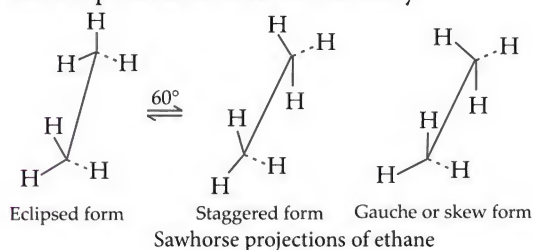
**Structural isomerism** : Alkanes exhibit only chain isomerism. Methane, ethane, propane do not exhibit isomerism.

Alkane	$C_4H_{10}$	$C_5H_{12}$	$C_6H_{14}$	$C_7H_{16}$	$C_8H_{18}$
No. of possible isomers	2	3	5	9	18

#### Conformations

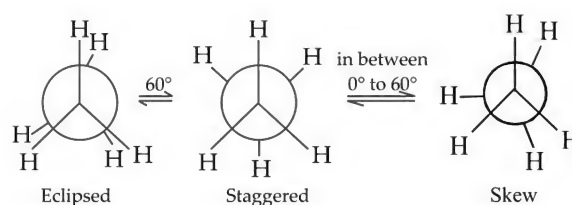
The different arrangements of atoms in space which can be obtained due to rotation about C—C bond are called conformations. To represent these conformations, we can draw three-dimensional pictures. Two simple ways to represent them are :

- **Sawhorse projections** : It is a view of molecule at a particular C – C bond and groups connected to both the front and back carbons are drawn using sticks at  $120^\circ$  angle. The left-hand bottom end of this, locates atoms nearer to the observer and right-hand top end atoms are farther away.





- Newman projections** : In Newman projection, the two carbon atoms forming the  $\sigma$ -bond are represented by two circles, one behind the other, so that only front carbon is seen. The hydrogen atoms attached to the front carbon are shown by the bonds from the centre of the circle while the atoms attached to the back carbon are shown by the bonds from the circumference.

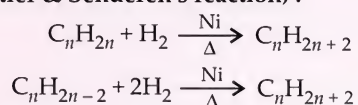


Newman's projections of ethane

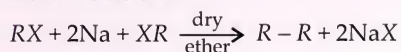
## Methods of Preparation

### 1. By hydrogenation of unsaturated hydrocarbons

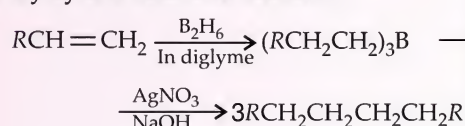
(Sabatier & Senderen's reaction) :



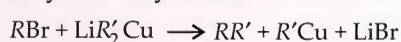
### 2. Wurtz reaction :



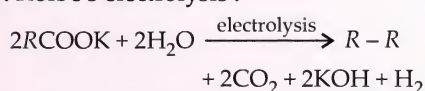
### 3. By hydroboration of alkenes :



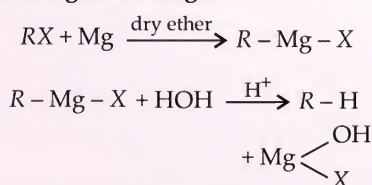
### 4. Corey-House synthesis :



### 5. Kolbe's electrolysis :

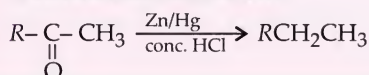


### 6. From Grignard's reagent :



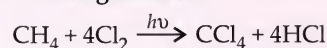
### 7. From carbonyl compounds

(Clemmensen reduction) :

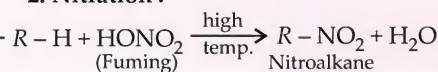


## Chemical Properties

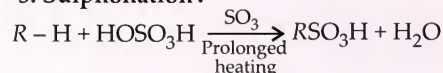
### 1. Halogenation :



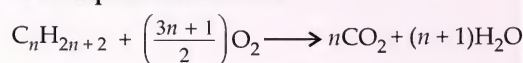
### 2. Nitration :



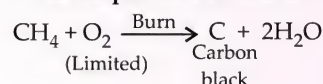
### 3. Sulphonation :



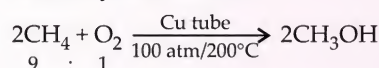
### 4. Complete combustion :



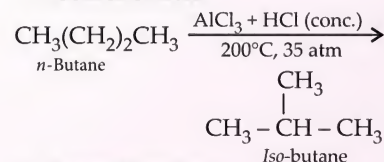
### 5. Incomplete combustion :



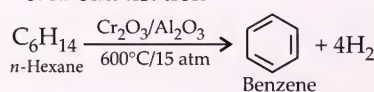
### 6. Catalytic oxidation :



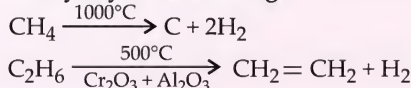
### 7. Isomerisation :



### 8. Aromatisation :



### 9. Pyrolysis or cracking :



## ALKANE

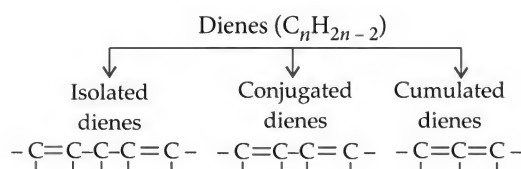
## ALKENES

- General formula :  $\text{C}_n\text{H}_{2n}$
- General representation :  $\text{RR}_1\text{C}=\text{CR}_2\text{R}_3$
- Hybridisation ( $\text{C}=\text{C}$ ) :  $sp^2$
- Geometry : Planar triangular

- Larger members of the series react with chlorine to form oily products thus, these are also known as olefins.

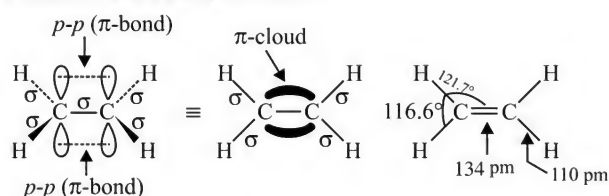
## Dienes

Alkenes with two double bonds are known as dienes.



## Structure of Double Bond

The  $C=C$  bond often known as ethylenic double bond, is made up of a sigma ( $\sigma$ ) bond and a pi ( $\pi$ ) bond. The sigma bond is a strong bond having bond dissociation enthalpy of about  $397 \text{ kJ mol}^{-1}$  while pi bond is a weak bond having bond dissociation enthalpy of about  $284 \text{ kJ mol}^{-1}$ . This is because  $\sigma$ -bond is formed by head on overlapping of orbitals while the  $\pi$ -bond is formed by lateral or sidewise overlapping of the orbitals. Since, extent of overlapping is less in case of  $\pi$ -bond than  $\sigma$ -bond, therefore, a  $\pi$ -bond is weaker bond than a  $\sigma$ -bond.



## Chemical Properties

<b>Alkene</b>	<b>Addition of hydrogen</b> $\xrightarrow[523-573 \text{ K}]{H_2/Ni, Pt, \text{ or } Pd} R-CH_3$
	<b>Addition of halogens</b> $\xrightarrow{Br_2/CCl_4} RCHBrCH_2Br$
	<b>Addition of halogen acids</b> $\xrightarrow[(X=Br, Cl, I)]{HX} R-\underset{\substack{  \\ X}}{CH}-CH_3$ (Markovnikov's rule) $\xrightarrow{HBr/Peroxide} R-CH_2-CH_2Br$ (Anti-Markovnikov's rule)
	<b>Addition of water (hydration)</b> $\xrightarrow{H_2O/H_2SO_4} R-\underset{\substack{  \\ OH}}{CH}-CH_3$ (Markovnikov's rule)
	<b>Hydroboration – oxidation</b> $\xrightarrow{B_2H_6/H_2O_2(alk.)} RCH_2CH_2OH$
	<b>Oxymercuration – demercuration</b> $\xrightarrow[H_2O]{(CH_3COO)_2Hg/THF} R-\underset{\substack{  \\ OH}}{CH}-CH_3$

## Methods of Preparation

<b>Dehydration of alcohols</b> $R-OH \xrightarrow[443 \text{ K}]{\text{conc. } H_2SO_4} R-OH \xrightarrow[623 \text{ K}-673 \text{ K}]{Al_2O_3}$	<b>A</b>
<b>Dehydrohalogenation of alkyl halides</b> $R-Br + KOH_{(liq.)} \xrightarrow{\Delta}$	<b>L</b>
<b>Dehalogenation of dihalides</b> $RCH(Br)CH(Br)R \xrightarrow[\text{Ethanol, } \Delta]{Zn/Cu}$	<b>K</b>
<b>Partial hydrogenation of alkynes</b> $R-C\equiv C-R \xrightarrow[\text{(Lindlar's catalyst)}]{H_2, Pd/CaCO_3}$ $R-C\equiv C-R \xrightarrow[\text{(Birch reduction)}]{Na/liq. NH_3}$	<b>E</b> <b>N</b>
<b>Kolbe's electrolytic method</b> $\begin{matrix} CH_2COONa \\   \\ CH_2COONa \end{matrix} \xrightarrow{\text{Electrolysis}}$	<b>E</b>

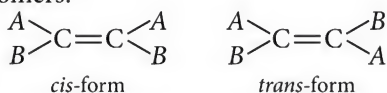
<b>Alkene</b>	<b>Oxidation</b> $\xrightarrow[\text{Cold}]{\text{alk. } KMnO_4} R\underset{\substack{  \\ OH}}{CH}-\underset{\substack{  \\ OH}}{CH_2}$
	<b>Ozonolysis</b> $\xrightarrow{O_3, Zn/H_2O} RCHO \text{ or } R_2CO$
	<b>Polymerisation</b> $\xrightarrow[1500 \text{ atm, } 473-673 \text{ K}]{\text{Traces of oxygen}} \left( \overset{\substack{R \\  }}{CH}-CH_2 \right)_n$
	<b>Wacker process</b> $\underset{\text{Ethene}}{H_2C=CH_2} + PdCl_2 + H_2O \xrightarrow[Acetaldehyde]{323 \text{ K}} CH_3CHO + Pd + 2HCl$
	<b>Diels–Alder reaction</b> $\begin{matrix} CH_2 \\ // \\ CH \\   \\ CH \\ // \\ CH_2 \end{matrix} + \begin{matrix} CH_2 \\    \\ CH_2 \end{matrix} \rightarrow \begin{matrix} CH_2 & & CH_2 \\ / & & \backslash \\ CH & & CH \\   & &   \\ CH & & CH \\ \backslash & & / \\ CH_2 & & CH_2 \end{matrix}$ Buta-1,3-diene (Diene)      Ethylene (Dienophile)      Cyclohexene



## Isomerism

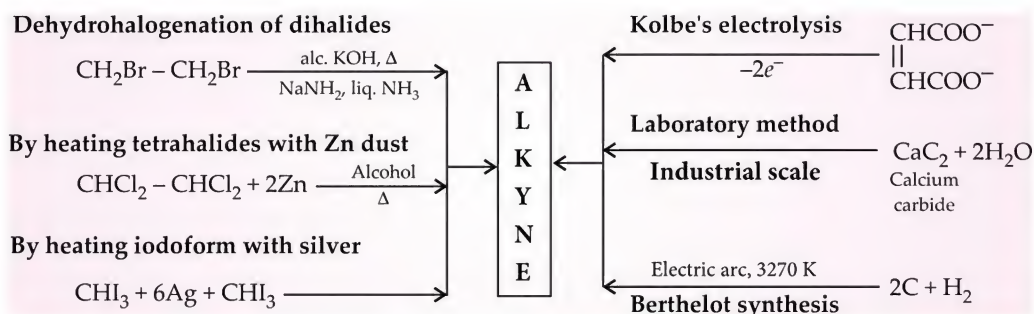
Alkenes exhibit the following isomerism :

- **Structural isomerism** : Alkenes show chain isomerism (isomers differ with respect to chain of carbon atoms) and position isomerism (isomers differ in the position of the double bond).
- **Geometrical isomerism** : Geometrical isomers are the stereoisomers which have different arrangements of groups or atoms around rigid framework of double bonds. This type of isomerism arises due to restricted rotation around double bond. Isomer in which similar groups or atoms lie on the same side of double bond are called *cis*-isomers whereas isomer in which similar groups or atoms lie on the opposite sides of double bond are called *trans*-isomers.



- **Necessary conditions for Geometrical isomerism** :  
– The molecule must have a C=C double bond.

## Methods of Preparation



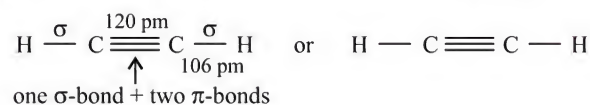
- Two atoms or groups attached to doubly bonded carbon atoms must be different.

## ALKYNES

- General formula :  $\text{C}_n\text{H}_{2n-2}$
- General representation :  $\text{R}_1\text{C}\equiv\text{CR}_2$
- Hybridisation ( $\text{C}\equiv\text{C}$ ) :  $sp$
- Geometry : Linear

### Structure of Triple Bond

The simplest member of this homologous series (putting,  $n = 2$ ) has the molecular formula,  $\text{C}_2\text{H}_2$ .



### Acidic nature

Alkynes are weakly acidic in nature. As  $s$ -character increases, acidic nature increases.

	Alkynes	Alkenes	Alkanes
Hybridisation :	$sp$	$sp^2$	$sp^3$ (acidic nature)
$s$ -character :	50%	33.3%	25%

## INFOSHOTS

### From C—H to C—C at room temperature!

Recently a new method is devised to selectively introduce aryl groups into C—H bonds at room temperature which is different from conventional idea.

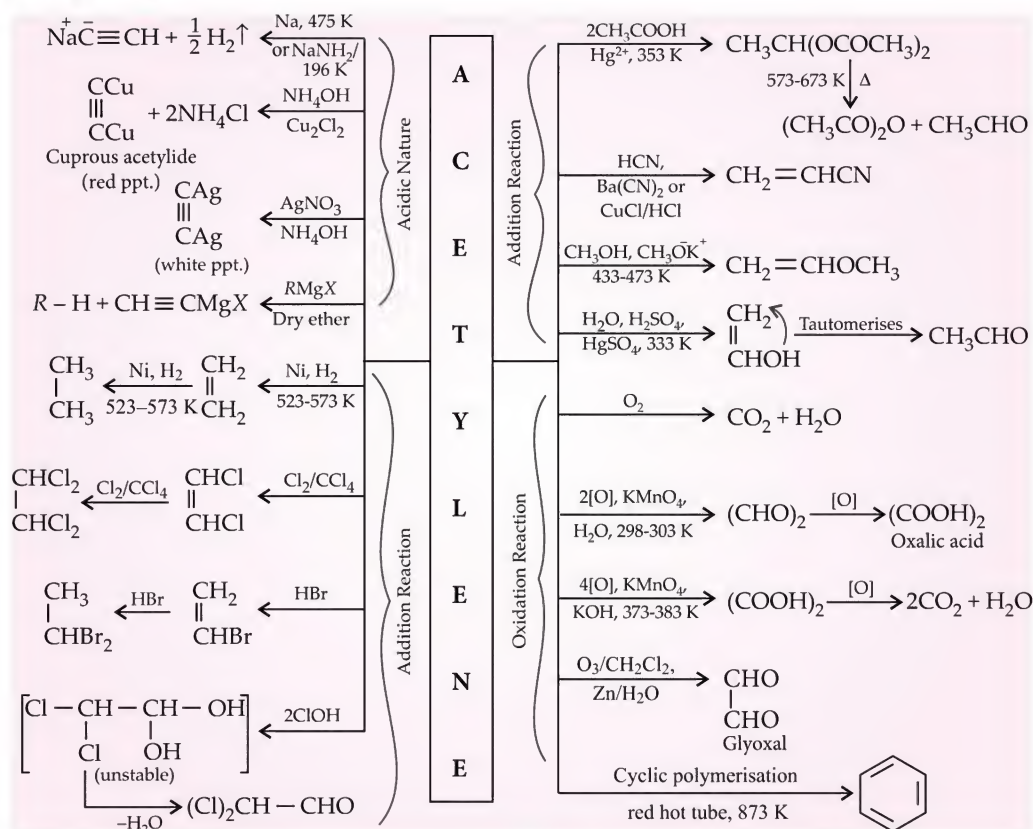
Firstly, iridium catalyst activates C—H containing substrate, then arylsilane attacks the metal creating an intermediate, then oxidation of iridium centre of intermediate causes arylation reaction.

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## Chemical Properties



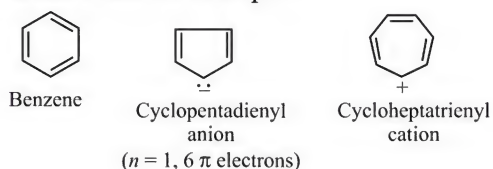
## Aromatic Hydrocarbons

- Hydrocarbons with sigma bonds and delocalized pi-electrons between carbon atoms forming a ring.
- They show aromaticity and burn with a sooty flame.
- Carbon-hydrogen ratio is high.
- They undergo electrophilic substitution reactions and nucleophilic aromatic substitutions.

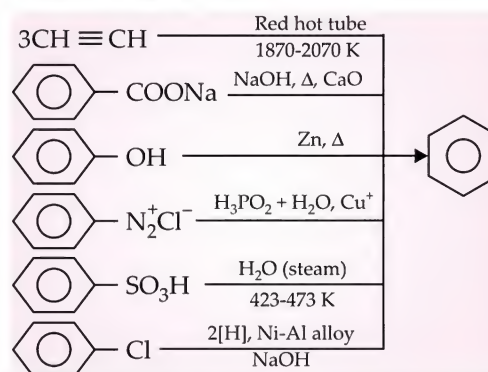
### Huckel Rule of Aromaticity

Huckel rule of aromaticity is applied to all the ring systems (whether they have benzene ring or not) which possess the following characteristics :

- Planarity
- Complete delocalisation of  $\pi$ -electrons in the ring.
- Presence of  $(4n + 2)\pi$ -electrons in the ring where,  $n = 0, 1, 2, 3, \dots$ , for example,



## Methods of Preparation

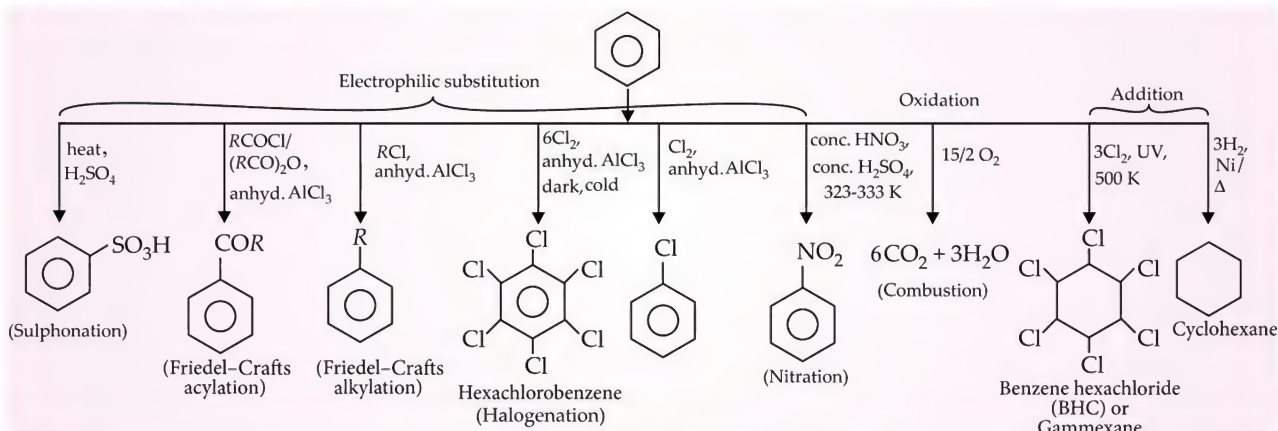


## MPP-10 CLASS XI ANSWER KEY

- |             |           |               |         |             |
|-------------|-----------|---------------|---------|-------------|
| 1. (b)      | 2. (a)    | 3. (c)        | 4. (c)  | 5. (a)      |
| 6. (b)      | 7. (d)    | 8. (b)        | 9. (a)  | 10. (d)     |
| 11. (b)     | 12. (b)   | 13. (c)       | 14. (d) | 15. (a)     |
| 16. (a)     | 17. (a)   | 18. (b)       | 19. (c) | 20. (a,b,d) |
| 21. (a,b,c) | 22. (a,c) | 23. (a,b,c,d) |         |             |
| 24. (3)     | 25. (3)   | 26. (4)       | 27. (c) | 28. (b)     |
| 29. (b)     | 30. (c)   |               |         |             |



## Chemical Properties



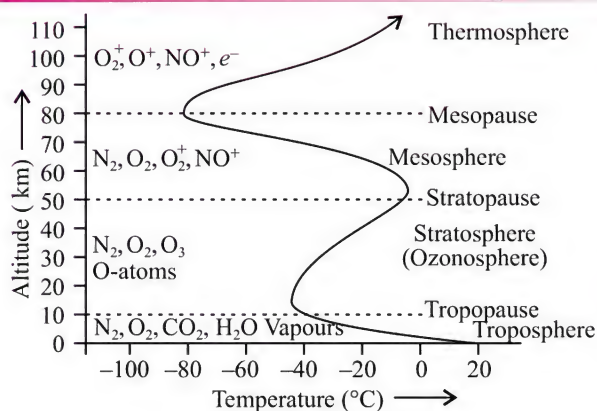
## DISTINCTION TESTS FOR ALKANES, ALKENES AND ALKYNES

	Test	Alkane (ethane)	Alkene (ethene)	Alkyne (ethyne)
1.	$\text{Br}_2/\text{CCl}_4$	–	Decolourises. Dibromo derivatives, $\text{C}_2\text{H}_4\text{Br}_2$	Decolourises. Tetrabromo derivatives, $\text{C}_2\text{H}_2\text{Br}_4$
2.	Baeyer's reagent (Alk. $\text{KMnO}_4$ )	–	Decolourises. $\begin{array}{c} \text{CH}_2 \\    \\ \text{CH}_2 \end{array} + \text{H}_2\text{O} + \text{O} \rightarrow \begin{array}{c} \text{CH}_2\text{OH} \\   \\ \text{CH}_2\text{OH} \end{array}$	Decolourises. $\begin{array}{c} \text{CH} \\     \\ \text{CH} \end{array} + 4[\text{O}] \rightarrow \begin{array}{c} \text{COOH} \\   \\ \text{COOH} \end{array}$
3.	Ammoniacal $\text{Cu}_2\text{Cl}_2$	–	–	Red precipitate
4.	Ammoniacal silver nitrate	–	–	White precipitate

## ENVIRONMENTAL CHEMISTRY

Environmental chemistry is the branch of chemistry that deals with the study of various chemical processes taking place in the various segments of the environment.

### REGIONS OF THE ATMOSPHERE



## INFOSHOTS

### First direct proof of ozone hole recovery!

For the first time, scientists have shown through direct satellite observations of the ozone hole that levels of ozone-destroying chlorine are declining (due to international ban on chlorofluorocarbons), resulting in 20 per cent less ozone-depletion during the Antarctic winter than there was in 2005.

### AIR POLLUTION

It is the addition of undesirable materials into the atmosphere either due to natural phenomena or due to human activity on the earth which adversely affect the quality of the air and hence, affects the life on the earth.

Pollutants	Major sources	Effects
CO	Incomplete combustion of carbonaceous matter in automobile engines and defective furnaces, incomplete combustion of agricultural and slash matter, volcanic eruptions, forest fires.	Carbon monoxide is toxic. It binds with haemoglobin in red blood cells and prevents them from combining with oxygen. Low levels of CO cause headache and dizziness. Concentration of ~1% causes death in minutes.
NO <sub>x</sub>	Combustion of fuel, natural forest fires, stationary combustion sources (factories and power plants), transportation.	Toxic to living tissues, harmful to paints, textiles and metals.
SO <sub>x</sub>	Stationary combustion sources, industries involved in metallurgy, coal, decay products, volcanoes.	They are respiratory tract irritants, low concentration causes throat, eye irritation and breathlessness, affect larynx.
Hydrocarbons	Combustion of fuel in automobiles, refineries, anaerobic bacterial decomposition of organic matter, natural gas.	At concentration greater than 500–1000 ppm, they have carcinogenic effect in lungs. They react with O <sub>2</sub> and NO <sub>x</sub> to form photochemical smog which have a strong damaging effect on human beings as well as on plants.
CFC's	CFC's were used primarily as refrigerants, in aerosol sprays and in the plastic industry. Freons are stable (lasts for over 80 years), inflammable and inert (in the lower atmosphere).	React with stratospheric ozone. When CFC's are broken down, chlorine free radicals are produced. These can react with more than 10,000 molecules of ozone thus, depleting the ozone layer.
Particulates	Volcanic eruptions, fly ash, smelting and mining operations, smoke from incomplete combustion, dust from crushers and grinders.	Inhalation of metallic particles leads to respiratory disorders like asthma, bronchitis, lung cancer, etc.

## Smog

- The word smog is derived from smoke and fog. It is the major air pollutant.



- Smog is of two types :

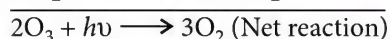
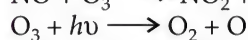
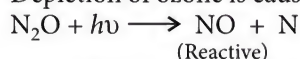
Classical smog	Photochemical smog
Also called as London smog.	Also called as Los Angeles smog.
Formed due to oxides of sulphur.	Formed due to oxides of nitrogen.
Contains primary pollutants.	Contains secondary pollutants.
Causes bronchitis and problems in lungs.	Causes irritation in eyes.
It is reducing in nature.	It is oxidising in nature.

## Stratospheric Pollution

**Ozone depletion :** The ozone layer existing between 15 to 25 km above the earth's surface, shield the earth from the harmful UV radiations from the sun. The UV

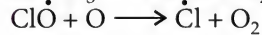
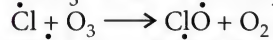
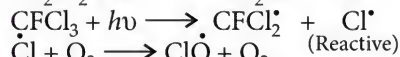
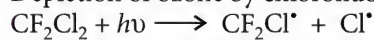
radiations cause skin cancer, eye cataract, and harmful to vegetation.

- Depletion of ozone is caused by oxides of nitrogen :



- The presence of oxides of nitrogen increase the decomposition of O<sub>3</sub>.

- Depletion of ozone by chlorofluorocarbons :



## GREENHOUSE EFFECT AND GLOBAL WARMING

The retention of heat by the earth and atmosphere from the sun and its prevention to escape into the outer space is known as greenhouse effect.



- Greenhouse gases such as CO<sub>2</sub>, ozone, methane, chlorofluorocarbons and water vapours form a thick cover around the earth which prevents the IR rays emitted by the earth to escape.
- It gradually leads to increase in temperature of atmosphere. This phenomenon of increasing earth's temperature is called global warming.
- The relative contribution of different greenhouse gases :  
CO<sub>2</sub>(50%), CH<sub>4</sub>(19%), CFC's(17%), O<sub>3</sub>(8%), N<sub>2</sub>O(4%), H<sub>2</sub>O(2%)

### Methods to prevent global warming

- By minimising uses of cars.
- By plantation.
- By avoiding burning of dry leaves, etc.

### ACID RAIN

- The oxides of C, N and S present in the atmosphere, dissolve in water and produce acids which lower the pH of rain water below 5.6. This is known as acid rain.
- The acids are toxic to vegetation, react with marble and damage buildings, corrode water pipes and produce salts with heavy metal ions *viz.*, Cu, Pb, Hg and Al which are toxic in nature.

### WATER POLLUTION

- Water pollution is defined as, the contamination of water by foreign substances which makes it harmful for health of animals, plants or aquatic life and makes it unfit for domestic, industrial and agricultural use.

Pollutants	Major sources
Natural wastes	Leaching of minerals, silt from soil erosion, falling of organic matter from banks, etc.
Organic chemicals	Pesticides, surfactants, detergents, industrial wastes.
Metals (Hg, As, Pb, Cd, etc.)	Nuclear power plants, mining, metal plating industries.
Man-made wastes	Sewage, domestic wastes, soaps and detergents, wastes from animal sheds and slaughter houses, run off from agricultural fields, industrial wastes.

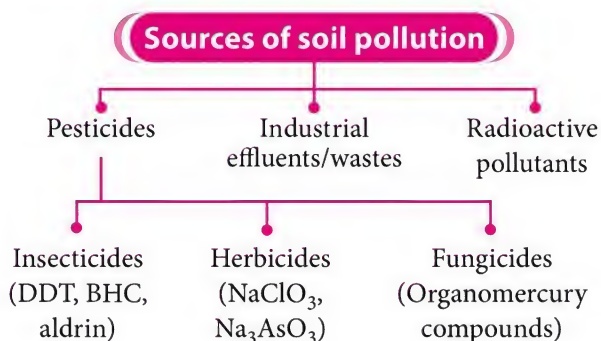
- Biochemical Oxygen Demand (BOD)** : It is defined as, the amount of free oxygen required for biological oxidation of the organic matter by aerobic conditions at 20°C for a period of five days. Its unit is mg/L or ppm. An average sewage has BOD value of 100 to 150 mg/L.
- Chemical Oxygen Demand (COD)** : It is measure of all types of oxidisable impurities (biologically oxidisable and biologically inert organic matter such as cellulose) present in the sewage. COD values are higher than BOD values.

### Eutrophication

- Eutrophication is a process whereby water bodies, receive excess nutrients that stimulate excessive plant growth (algae, periphyton attached algae and other plant weeds). This enhanced plant growth, often called an algal bloom, reduces dissolved oxygen in the water.

### SOIL POLLUTION

- The addition of substances in an indefinite proportion changing the productivity of the soil is known as soil pollution.



### Effects of Soil Pollution

- Pollution runs-off into rivers and kills the fishes, plants and other aquatic life.
- Contaminated soil decreases soil fertility and hence, there is decrease in the crop yield.
- People living near polluted land tend to have higher incidences of migraine, nausea, fatigue, skin disorders and even miscarriages.

## Control of Soil Pollution

- Reuse and recycle unwanted items.
- Make use of organic fertilizers and organic pesticides because they are usually made of natural substances so, are biodegradable.
- Cut down the usage of paper or use recycled paper.

## CONTROL OF ENVIRONMENTAL POLLUTION

- **Waste management** : Environmental pollution can be controlled to a certain extent by managing the waste disposal in a proper way.
- **Recycling** : A large amount of disposed waste material can be reused by recycling the waste. Thus, it reduces the land fill and converts waste into usable forms.
- **Incineration** : Incineration is a waste treatment technology that involves the combustion of organic

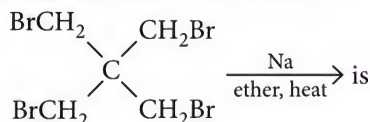
materials and/or substances. Incineration of waste materials converts the waste into ash, flue gases particulates and heat, which can in turn be used to generate electricity. Incinerators reduce the volume of the original waste by almost 95%.

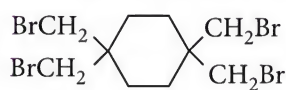
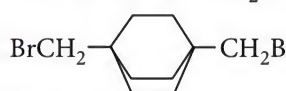

## GREEN CHEMISTRY

- Green chemistry is a chemical philosophy encouraging the design of products and processes that reduce or eliminate the use and generation of hazardous substances.
- Green chemistry refers to the redesign of chemical products and processes with the goal of reducing or eliminating any negative environmental or health effects. Examples of green chemistry projects include : finding non-toxic, non-volatile solvent substitutes, developing new catalysts and environmental friendly materials.

# SPEED PRACTICE

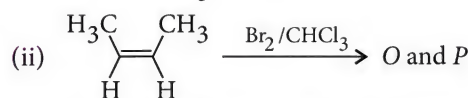
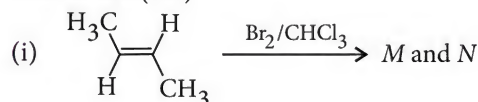
1. The product formed in the reaction,



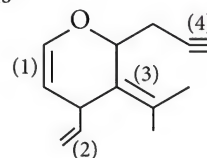
- (a)  $(\text{BrCH}_2)_3\text{CCH}_2\text{CH}_2\text{C}(\text{CH}_2\text{Br})_3$
- (b) 
- (c) 
- (d) 
2. 5 L aqueous solution is kept in the presence of oxygen and suitable microorganism for five days at 20 °C. If the O<sub>2</sub> consumed is 0.2 g, the BOD value of the sample is  
(a) 4 ppm (b) 0.4 ppm (c) 40 ppm (d) 20 ppm
3. Which of the following reacts with KMnO<sub>4</sub> but does not react with AgNO<sub>3</sub>?  
(a) C<sub>2</sub>H<sub>6</sub> (b) CH<sub>4</sub> (c) C<sub>2</sub>H<sub>4</sub> (d) C<sub>2</sub>H<sub>2</sub>
4. Peeling of ozone umbrella is due to

- (a) CFCs (b) PAN  
(c) CO<sub>2</sub> (d) coal burning.

5. The correct statement(s) for the following addition reactions is(are)



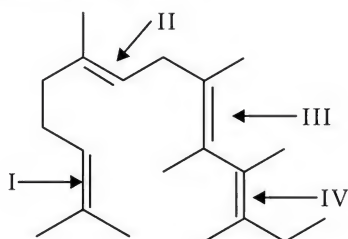
- (a) O and P are identical molecules  
(b) bromination proceeds through *trans*-addition in both the reactions  
(c) (M and O) and (N and P) are two pairs of enantiomers  
(d) (M and O) and (N and P) are two pairs of diastereomers. (JEE Advanced 2017)
6. The correct reactivity order of the labelled bonds towards Br<sup>+</sup> is





- (a)  $4 > 3 > 2 > 1$  (b)  $3 > 2 > 1 > 4$   
 (c)  $1 > 3 > 4 > 2$  (d)  $1 > 3 > 2 > 4$

7. Which of the following elements will cause mottling of teeth if present in drinking water?  
 (a) Mercury (b) Fluorine  
 (c) Boron (d) Chlorine
8. Propyne and propene can be distinguished by  
 (a) conc.  $\text{H}_2\text{SO}_4$  (b)  $\text{Br}_2$  in  $\text{CCl}_4$   
 (c) dil.  $\text{H}_2\text{SO}_4$  (d)  $\text{AgNO}_3$  in ammonia.
9. In the following structure, the double bonds are marked as I, II, III and IV :



Geometrical isomerism is not possible at site(s)

- (a) I (b) III  
 (c) I and III (d) III and IV  
**(JEE Main Online 2017)**
10. Cetane is a compound which has very good ignition property. Chemically, it is  
 (a)  $\text{CH}_3(\text{CH}_2)_{14}\text{CH}_3$  (b)  $(\text{CH}_3)_3\text{C}(\text{CH}_2)_{11}\text{CH}_3$   
 (c)  $\text{C}_{17}\text{H}_{34}$  (d) none of these.
11. Soil salinity can be measured by  
 (a) calorimeter (b) potometer  
 (c) porometer (d) conductivity meter.
12. Which of the following is a sink for CO?  
 (a) Microorganisms present in the soil  
 (b) Oceans  
 (c) Plants  
 (d) Haemoglobin  
**(NEET 2017)**

13. An isomer of  $\text{C}_5\text{H}_{12}$  gives total six isomeric products on monochlorination. What will be the percentage yield of the primary monochloride which is chiral? Consider the following relative reactivity of C—H bonds for chlorination :

Degree of C—H	$1^\circ\text{C—H}$	$2^\circ\text{C—H}$	$3^\circ\text{C—H}$
Relative reactivity for chlorination	1	3	5

- (a) 26.8% (b) 25% (c) 30% (d) 50%
14. The chemical entities present in thermosphere of the atmosphere are

- (a)  $\text{O}_2^+$ ,  $\text{O}^+$ ,  $\text{NO}^+$  (b)  $\text{O}_3$   
 (c)  $\text{N}_2$ ,  $\text{O}_2$ ,  $\text{CO}_2$ ,  $\text{H}_2\text{O}$  (d)  $\text{O}_3$ ,  $\text{O}_2^+$ ,  $\text{O}_2$

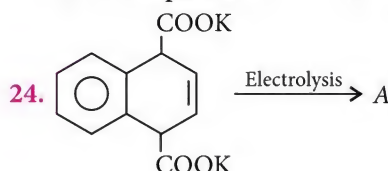
15. Which one of the following heptanols can be dehydrated to hept-3-ene only?  
 (a) Heptan-3-ol (b) Heptan-4-ol  
 (c) Heptan-2-ol (d) Heptan-1-ol
16. The best method to prepare cyclohexene from cyclohexanol is by using  
 (a) conc.  $\text{HCl}$  +  $\text{ZnCl}_2$  (b) conc.  $\text{H}_3\text{PO}_4$   
 (c)  $\text{HBr}$  (d) conc.  $\text{HCl}$
17. The pair of electrons in the given carbanion,  $\text{CH}_3\text{C} \equiv \text{C}^-$ , is present in which of the following orbitals?  
 (a)  $sp^2$  (b)  $sp$  (c)  $2p$  (d)  $sp^3$

**(NEET Phase-I 2016)**

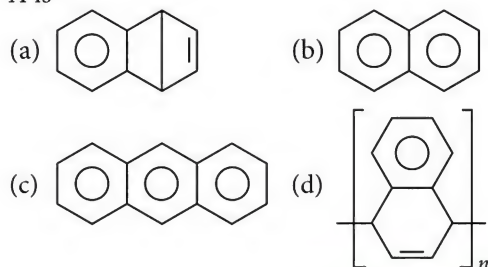
18. Increased asthmatic attacks in certain seasons are related to  
 (a) inhalation of seasonal pollen  
 (b) eating of seasonal vegetables  
 (c) low temperature  
 (d) wet and dry environment.
19. Which of the following reagents can be used for the conversion of  $\text{C}_6\text{H}_5\text{CH}_2\text{CH}_3$  to  $\text{C}_6\text{H}_5\text{CH}=\text{CH}_2$ ?  
 (a)  $\text{SOCl}_2$ ;  $\text{H}_2\text{O}$  (b)  $\text{SO}_2\text{Cl}_2$ ; alc.  $\text{KOH}$   
 (c)  $\text{Cl}_2/h\nu$ ;  $\text{H}_2\text{O}$  (d)  $\text{SOCl}_2$ ; alc.  $\text{KOH}$
20. Ethylidene dichloride is obtained by the reaction of excess of  $\text{HCl}$  with  
 (a) ethylene (b) acetylene  
 (c) propene (d) methane.
21. The compound that will react most readily with gaseous bromine, has the formula  
 (a)  $\text{C}_3\text{H}_6$  (b)  $\text{C}_2\text{H}_2$  (c)  $\text{C}_4\text{H}_{10}$  (d)  $\text{C}_2\text{H}_4$

**(NEET Phase-II 2016)**

22. Persistent pesticides such as DDT pass into food chain and increase in amount per unit weight of organism due to their accumulation in fat. This phenomenon is called  
 (a) biomagnification (b) biodegradation  
 (c) biosynthesis (d) decomposition.
23. Cyclone collector is used for minimising  
 (a) radioactive pollution (b) air pollution  
 (c) noise pollution (d) water pollution.




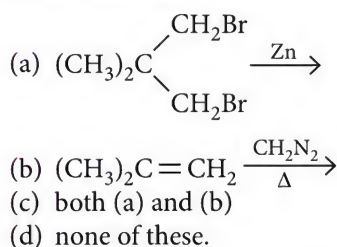
A is



(JEE Main Online 2015)

25. The dihedral angle HCH in staggered conformation of  $C_2H_6$  is  
 (a)  $120^\circ$  (b)  $60^\circ$  (c)  $0^\circ$  (d)  $90^\circ$

26. 1,1-Dimethylcyclopropane,  can be obtained by the reaction



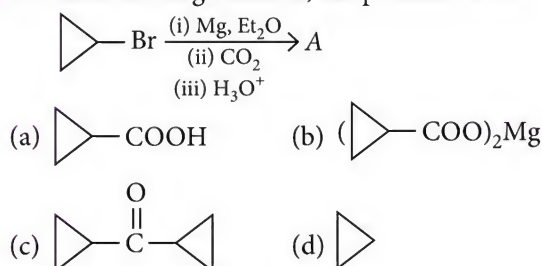
27. Photochemical smog consists of excessive amount of X, in addition to aldehydes, ketones, peroxyacetyl nitrates (PAN) and so forth. X is  
 (a)  $CH_4$  (b) CO (c)  $CO_2$  (d)  $O_3$

(JEE Main Online 2015)

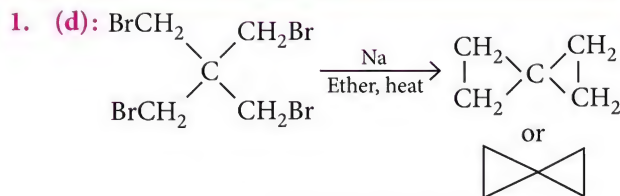
28.  $SO_2$  and  $NO_2$  produce pollution by increasing  
 (a) alkalinity (b) acidity  
 (c) neutrality (d) buffer action.

29. The brown haze of photochemical smog is largely attributable to  
 (a) NO (b)  $NO_2$   
 (c)  $CH_3-COONO_2$   
 $\quad \quad \quad \parallel$   
 $\quad \quad \quad O$   
 (d)  $CH_2=CHCH=O$

30. For the following reaction, the product 'A' is



## SOLUTIONS



2. (c):  $BOD = \frac{\text{Weight of oxygen (in mg)}}{\text{Volume of water sample (in L)}}$

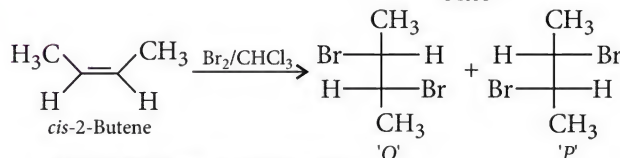
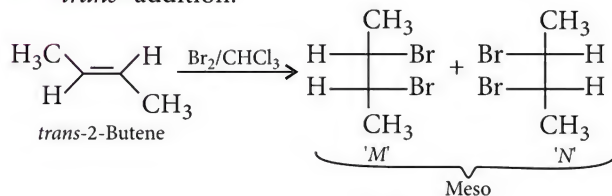
Given, Weight of oxygen = 0.2 g = 200 mg  
 Volume of solution = 5 L

$$BOD = \frac{200}{5} \text{ mg/L} = 40 \text{ mg/L} = 40 \text{ ppm}$$

3. (c):  $C_2H_6$  and  $CH_4$  are alkanes, they do not react with both  $KMnO_4$  and  $AgNO_3$ . Alkene ( $C_2H_4$ ) and alkyne ( $C_2H_2$ ) both react with  $KMnO_4$  and decolourise it. But only alkynes react with  $AgNO_3$  to give white precipitate.

4. (a): Peeling of ozone umbrella *i.e.*, ozone depletion is due to chlorofluorocarbons (CFCs).

5. (b, d): Bromination of alkenes always proceeds via *trans*-addition.



'O' and 'P' are enantiomers.

(M and O) and (N and P) are two pairs of diastereomers.

6. (d):  $C=C$  at position 1 is more reactive towards electrophile,  $Br^+$  as this is adjacent to O-atom to provide +M-effect.  $C=C$  at position 3 is more substituted as compared to  $C=C$  at position 2. Alkyne (at position 4) is less reactive towards  $Br^+$  as compared to alkene. Thus, the correct order of reactivity is  $1 > 3 > 2 > 4$ .

7. (b): Mottling of teeth is due to the presence of fluorine in drinking water.

8. (d): Propyne gives white ppt. with  $AgNO_3$  in ammonia (given only by terminal alkynes), but propene does not react.



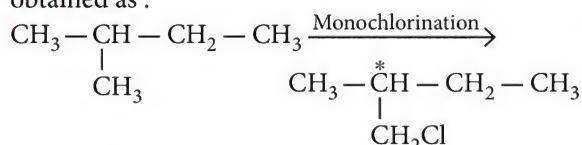
9. (a): For geometrical isomerism, different groups should be attached to each  $sp^2$  hybridised C-atom.

10. (a): Cetane is chemically hexadecane  $\text{CH}_3(\text{CH}_2)_{14}\text{CH}_3$  or  $\text{C}_{16}\text{H}_{34}$ . It is colourless liquid and straight chain hydrocarbon used in rating of diesel.

11. (d): Soil salinity can be measured by conductivity meter.

12. (a,d): Microorganisms present in the soil consume atmospheric CO. Haemoglobin has higher affinity for CO and it combines with CO to form carboxy-haemoglobin.

13. (c): Primary monochloride (which is chiral) is obtained as:

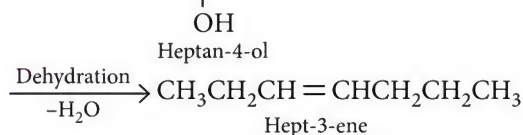


$6(1^\circ \text{H}) \times 1 = 6$  (Chiral);  $2(2^\circ \text{H}) \times 3 = 6$ ;  
 $1(3^\circ \text{H}) \times 5 = 5$ ;  $3(1^\circ \text{H}) \times 1 = 3$  (Not chiral)

$$\text{Now, \% yield} = \frac{6}{20} \times 100 = 30\%$$

14. (a)

15. (b):  $\text{CH}_3\text{CH}_2\text{CH}_2-\underset{\text{OH}}{\text{CH}}-\text{CH}_2\text{CH}_2\text{CH}_3$



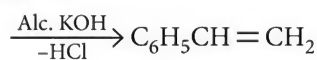
16. (b): Conc.  $\text{H}_3\text{PO}_4$  is a dehydrating agent and it will convert cyclohexanol to cyclohexene.

17. (b):  $\text{CH}_3-\overset{sp}{\text{C}}\equiv\overset{sp}{\text{C}}-$

Thus, pair of electrons is present in  $sp$ -hybridised orbital.

18. (a)

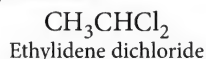
19. (b):  $\text{C}_6\text{H}_5\text{CH}_2\text{CH}_3 \xrightarrow[\text{-SO}_2, \text{-HCl}]{\text{SO}_2\text{Cl}_2} \text{C}_6\text{H}_5\text{CHClCH}_3$



20. (b):  $\text{CH}\equiv\text{CH} + \text{HCl} \longrightarrow \text{CH}_2=\text{CHCl}$

Acetylene

Vinyl chloride



Ethylidene dichloride

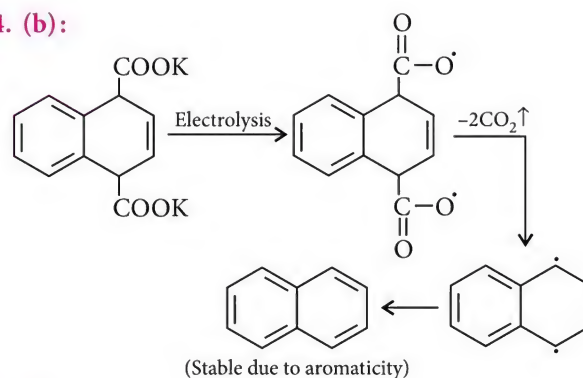
Alkenes due to presence of only one  $>\text{C}=\text{C}<$ , form only monochloro derivative.

21. (a)

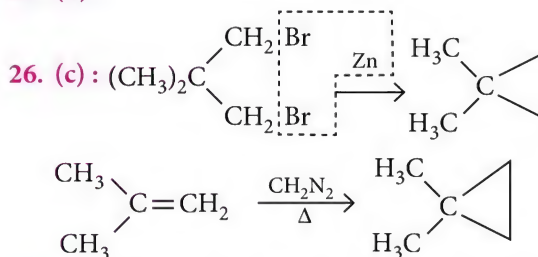
22. (a)

23. (b): Cyclone collector is used for minimising air pollution.

24. (b):



25. (b)

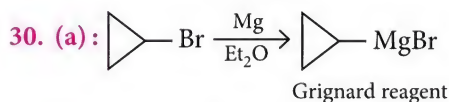
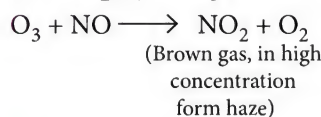
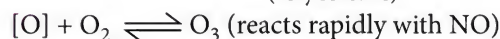
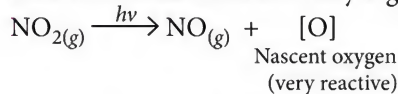


27. (d): Chemical pollutants in photochemical smog are nitrogen oxides ( $\text{NO}$  and  $\text{NO}_2$ ), volatile organic compounds, ozone ( $\text{O}_3$ ), peroxyacetyl nitrates.

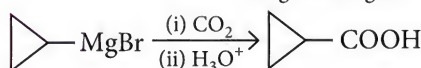
In the presence of sunlight, the following reactions take place:  $\text{NO}_2 \xrightarrow{h\nu} \text{NO} + \text{O}$ ;  $\text{O} + \text{O}_2 \longrightarrow \text{O}_3$ . Hence, it consists of excessive amount of ozone molecules also.

28. (b):  $\text{SO}_2$  and  $\text{NO}_2$  produce pollution by increasing acidity.

29. (b): Photochemical smog is initiated by the photochemical dissociation of  $\text{NO}_2$  that results in the formation of  $\text{NO}$ . This  $\text{NO}$  rapidly reacts with  $\text{O}_3$  (formed by molecular oxygen with  $\text{O}$ -atoms) to give  $\text{NO}_2$  (a brown gas), responsible for causing haze if its concentration is very high.



Grignard reagent



CLASS XI

# ACE

## YOUR WAY

CBSE



### Practice Paper 2018

Time Allowed : 3 hours  
Maximum Marks : 70

#### GENERAL INSTRUCTIONS

- (i) All questions are compulsory.
- (ii) Questions on every short answer questions and carry 1 mark each.
- (iii) Questions on short answer questions and carry 2 marks each.
- (iv) Questions on the short answer questions and carry 3 marks each.
- (v) Questions on short answer questions and carry 4 marks each.
- (vi) Questions on long answer questions and carry 5 marks each.
- (vii) Use of calculator is not allowed.

1. What is the difference between 2.0 g and 2.00 g?
2. Write the atomic number of the element present in the third period and seventeenth group of the periodic table.
3. Using the equation of state  $PV = nRT$ ; show that at a given temperature, density of a gas is proportional to gas pressure,  $P$ .
4. Hydrogen is relatively inert at room temperature. Explain.
5. Why graphite conducts electricity although it is a non-metal?
6. Explain that the effect of the Heisenberg uncertainty principle is significant only for motion of microscopic objects and is negligible for that of macroscopic objects.
7. State the law of multiple proportions. Give one example.
8. Phosphoric acid is preferred over sulphuric acid in preparing hydrogen peroxide from peroxides. Why?
9. Explain how an oxidation-reduction reaction can occur even though the reactants and products are physically separated from one another.
10. What do you mean by ozone hole? What are its consequences?
11. Write the complete sequence of energy levels in the increasing order of energy in nitrogen molecule. Compare the relative stability and the magnetic behaviour of the following species :  $N_2$ ,  $N_2^+$ ,  $N_2^-$ ,  $N_2^{2+}$ .
12. Prove that the excluded volume ' $b$ ' is four times the actual volume of the gas molecules.
13. (a) Define the terms :  
(i) Empirical formula (ii) Molecular formula.  
(b) An organic compound on analysis gave the following percentage composition : C = 57.8%, H = 3.6% and the rest is oxygen. The vapour density of the compound was found to be 83. Find out the molecular formula of the compound.

OR

What mass of silver nitrate will react with 5.85 g of sodium chloride to produce 14.35 g of silver chloride and 8.5 g of sodium nitrate, if the law of conservation of mass is true?



14. Why is LiF almost insoluble in water, whereas LiCl is soluble not only in water, but also in acetone?

15. Answer the following questions :

- (i) What physical meaning is attributed to the square of the absolute value of wave function  $|\Psi^2|$ ?
- (ii) Which lowest shell has *f*-subshell?
- (iii) Which quantum number indicates the size of the orbital?

16. Answer the following :

- (i) Sulphur has lesser ionization enthalpy than phosphorus.
- (ii) Arrange the following in increasing order of first ionisation potential : Na, Al, Mg and Si.
- (iii) Among the following oxides, which is most acidic?  
 $\text{MgO}$ ,  $\text{Al}_2\text{O}_3$ ,  $\text{P}_2\text{O}_5$  and  $\text{SiO}_2$

17. A heated copper block at  $130^\circ\text{C}$  loses 340 J of heat to the surroundings at room temperature of  $32^\circ\text{C}$ . Calculate :

- (i) the entropy change of the system (copper block)
- (ii) the entropy change in the surroundings
- (iii) the total entropy change in the universe due to this process.

Assume that the temperature of the block and the surroundings remains constant.

18. Answer the following :

- (i) What is the role of porous diaphragm of asbestos used in the Castner-Kellner cell?
- (ii) State any two properties of sodium hydroxide.

OR

What is plaster of Paris and how it is prepared? Describe its chief property due to which it is widely used.

19. Suggest a method to purify :

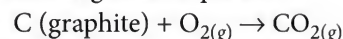
- (i) camphor containing traces of common salt
- (ii) kerosene oil containing water
- (iii) a liquid which decomposes at its boiling point.

20. Explain the following :

- (i) The boiling point of water (373 K) is abnormally high when compared to that of  $\text{H}_2\text{S}$  (211.2 K).
- (ii) Liquids like ether and acetone are kept in cool places.
- (iii) Tea or coffee is sipped from a saucer when it is quite hot.

21. 1 g of graphite is burnt in a bomb calorimeter in excess of oxygen at 298 K and 1 atmosphere

pressure according to the equation,



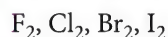
During the reaction, temperature rises from 298 K to 299 K. If the heat capacity of the bomb calorimeter is 20.7 kJ/K, what is the enthalpy change for the above reaction at 298 K and 1 atm?

22. A conjugated alkadiene having molecular formula,  $\text{C}_{13}\text{H}_{22}$  on ozonolysis yielded ethyl methyl ketone and cyclohexanecarbaldehyde. Identify the diene, write its structural formula and give its IUPAC name.

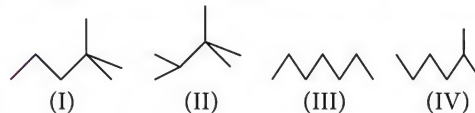
23. Ms. Shalini Sinha, a resident of Gurgaon, was observed one foggy night that there was a fire on the waste dumped in nearby area. She immediately called fire brigade to control over fire. In spite of that the waste pile was kept on burning for almost four days. As the dump was a mix of industrial and medical wastes, toxic fumes were released and there was a cloud of the smog that engulfed the area and made it difficult for residents to breathe, especially children. Residents of Gurgaon claimed their complaints to the state environment minister about incineration of garbage on open plots have not been addressed. They also requested government to check the big corporate organisation as these also throw the waste on the nearby open plots. Now answer the following questions :

- (i) What was the reason behind the formation of cloud of smog?
- (ii) What are different types of smog?
- (iii) How could the household and industrial waste be managed?
- (iv) What are the values possessed by Ms. Shalini Sinha?

24. (i) Arrange the following halogens in increasing order of reactivity towards alkanes :



(ii) Arrange the following in increasing order of energy released during their combustion :



(iii) Arrange the following in the increasing order of C — C bond length :  $\text{C}_2\text{H}_6$ ,  $\text{C}_2\text{H}_4$ ,  $\text{C}_2\text{H}_2$ .

(iv) Give a brief account for the following statements :

- (a) *n*-Pentane has greater boiling point than *iso*-pentane.
- (b)  $\text{CH}_4$  cannot be synthesized by Wurtz reaction.

OR

- (a) An alkyne (X) has molecular formula  $C_5H_8$ . It reacts neither with sodamide nor with ammoniacal cuprous chloride. Identify X.
- (b) A hydrocarbon 'Y' decolourises bromine water. On ozonolysis it gives 3-methylbutanal and formaldehyde. Give the name and structure of the compound.
- (c) A hydrocarbon (Z) has molecular formula,  $C_8H_{10}$ . It does not decolourise bromine water and is oxidised to benzoic acid on heating with  $K_2Cr_2O_7$ . It can also have three other isomers A, B and C. Write the structures of Z, A, B and C.
25. At 450 K,  $K_p = 2.0 \times 10^{10} \text{ bar}^{-1}$  for the given reaction at equilibrium :
- $$2SO_{2(g)} + O_{2(g)} \rightleftharpoons 2SO_{3(g)} + 189.4 \text{ kJ}$$
- (a) What is the value of  $K_c$  at this temperature?
- (b) What is the value of  $K_c$  for the reverse reaction at the same temperature?
- (c) What would be the effect on equilibrium if
- more  $SO_2$  is added
  - pressure is increased
  - temperature is increased?

OR

- (i) A sample of AgCl was treated with 5.00 mL of 1.5 M  $Na_2CO_3$  solution to give  $Ag_2CO_3$ . The remaining solution contained 0.0026 g of  $Cl^-$  per litre. Calculate the solubility product of AgCl. ( $K_{sp}$  for  $Ag_2CO_3 = 8.2 \times 10^{-12}$ ).
- (ii) The solubility of  $Pb(OH)_2$  in water is  $6.7 \times 10^{-6} \text{ M}$ . Calculate the solubility of  $Pb(OH)_2$  in a buffer solution of pH = 8.
26. (i) Arrange the following in increasing order of the property indicated :
- (a)  $CCl_2$ ,  $SiCl_2$ ,  $GeCl_2$ ,  $SnCl_2$  and  $PbCl_2$  (stability)
- (b) CO, SiO, SnO, GeO, PbO (basicity)
- (c)  $SiF_4$ ,  $SiCl_4$ ,  $SiI_4$ ,  $SiBr_4$  (stability)
- (ii) Account for the following :
- (a)  $BCl_3$  is a monomer while  $AlCl_3$  exist as a dimer.
- (b)  $AlCl_3$  exists but thallium forms only  $TlCl$ .

OR

Compound (X) on reduction with  $LiAlH_4$  gives a hydride (Y) containing 21.72% hydrogen along with other products. The compound (Y) reacts with air explosively resulting in boron trioxide. Identify (X) and (Y). Give balanced reactions involved in the formation of (Y) and its reaction with air. Draw the structure of (Y).

## SOLUTIONS

1. 2.0 g has two significant figures and hence, its precision is 0.1 part in 2, i.e., 50 parts per thousand. While 2.00 has three significant figures and hence, its precision is 0.01 parts in 2, i.e., 5 parts per thousand.

2. Cl belongs to the third period and seventeenth group of the periodic table and its atomic number is 17.

3.  $PV = nRT$

$$\text{or } P = \frac{wRT}{MV} \quad \left( \because n = \frac{w}{M} \right)$$

$$\text{or } P = \frac{dRT}{M} \quad \left( \because d = \frac{w}{V} \right)$$

or  $P \propto d$

Hence, density ( $d$ ) of a gas  $\propto P$ , as  $R$ ,  $T$  and  $M$  are constants.

4. Hydrogen is relatively inert at room temperature due to its high bond dissociation enthalpy.

5. Graphite has a layered structure in which each C atom is  $sp^2$  hybridised. Fourth valence electron of each carbon is free to move thus, graphite conducts electricity.

6. If uncertainty principle is applied to an object of a bigger mass like 1 mg or above, the value of uncertainty becomes extremely small or insignificant.

$$\Delta x \cdot \Delta p = \frac{h}{4\pi m} = \frac{6.626 \times 10^{-34}}{4 \times 3.14 \times 10^{-6}} = 0.53 \times 10^{-28} \text{ m}^2 \text{ s}^{-1}$$

The magnitude of uncertainty is so small that it is of no significance.

7. **Law of multiple proportions:** "When two elements combine to form more than one compound, then the masses of one of the elements which combine with a fixed mass of the other element are in a simple whole number ratio".

For example, carbon, combines with oxygen to form two compounds, namely, carbon dioxide and carbon monoxide. In carbon dioxide, 12 parts by mass of carbon combine with 32 parts by mass of oxygen while in carbon monoxide, 12 parts by mass of carbon combine with 16 parts by mass of oxygen. Therefore, the masses of oxygen which combine with a fixed mass of carbon (12 parts) in carbon monoxide and carbon dioxide are 16 and 32, respectively. These masses of oxygen bear a simple ratio of 16 : 32 or 1 : 2 to each other.

OR

Let  $x$  g of  $AgNO_3$  reacts with 5.85 g NaCl.





According to law of conservation of mass,  
mass of reactants = mass of products  
 $x + 5.85 = 14.35 + 8.5$  or  $x = 17.0$  g

**8.** Phosphoric acid (a weaker acid) is preferred over sulphuric acid during the preparation of  $\text{H}_2\text{O}_2$  from peroxides because  $\text{H}_2\text{SO}_4$  acts as a catalyst for decomposition of  $\text{H}_2\text{O}_2$ . Also,  $\text{H}_3\text{PO}_4$  acts as negative catalyst (preservative) for  $\text{H}_2\text{O}_2$  because  $\text{H}_3\text{PO}_4$  removes all heavy metals (catalyst for  $\text{H}_2\text{O}_2$  decomposition) in the form of insoluble phosphates.

**9.** An oxidation-reduction reaction can occur even though the reactants and products are physically separated because of transfer of ions through the salt bridge. The salt bridge performs the following functions:

- (a) acts as a link between the two aqueous solutions.
- (b) overcomes liquid junction potential.
- (c) maintains the electrical neutrality of the aqueous solution of the electrodes by releasing or sending oppositely charged ions into the solution.

**10.** The depletion of ozone layer is termed as ozone hole. Ozone layer is responsible for prevention of infiltration of UV rays which has the potential to cause serious damage to plants, animals and human life. Due to depletion of this ozone layer, these harmful rays will find an easy route into the earth's atmosphere and create problems such as mutation of cells leading to cancer of the skin or increased transpiration in plants and reduced water level in soil. Increase in UV radiations damages paints and fibres causing them to fade faster.

**11.** Sequence of energy levels in nitrogen molecule:

$$\sigma 1s < \sigma^* 1s < \sigma 2s < \sigma^* 2s < \pi 2p_x = \pi 2p_y < \sigma 2p_z < \pi^* 2p_x = \pi^* 2p_y < \sigma^* 2p_z$$

$$\text{N}_2 : \sigma 1s^2, \sigma^* 1s^2, \sigma 2s^2, \sigma^* 2s^2, \pi 2p_x^2 = \pi 2p_y^2, \sigma 2p_z^2$$

$$\text{B.O.} = \frac{1}{2} (10 - 4) = 3, \text{ diamagnetic}$$

$$\text{N}_2^+ : \sigma 1s^2, \sigma^* 1s^2, \sigma 2s^2, \sigma^* 2s^2, \pi 2p_x^2 = \pi 2p_y^2, \sigma 2p_z^1$$

$$\text{B.O.} = \frac{1}{2} (9 - 4) = 2.5, \text{ paramagnetic}$$

$$\text{N}_2^- : \sigma 1s^2, \sigma^* 1s^2, \sigma 2s^2, \sigma^* 2s^2, \pi 2p_x^2 = \pi 2p_y^2, \sigma 2p_z^2, \pi^* 2p_x^1$$

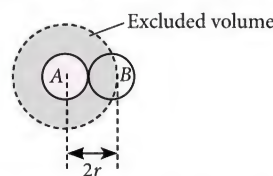
$$\text{B.O.} = \frac{1}{2} (10 - 5) = 2.5, \text{ paramagnetic}$$

$$\text{N}_2^{2+} : \sigma 1s^2, \sigma^* 1s^2, \sigma 2s^2, \sigma^* 2s^2, \pi 2p_x^2 = \pi 2p_y^2$$

$$\text{B.O.} = \frac{1}{2} (8 - 4) = 2, \text{ diamagnetic}$$

$$\text{Stability order} : \text{N}_2 > \text{N}_2^- = \text{N}_2^+ > \text{N}_2^{2+}$$

**12.** Consider two molecules A and B. Taking the molecules to be spherical, if  $r$  is the radius of the molecules then the distance of closest approach between the two molecules =  $2r$  (as shown in figure). This is the distance between the centres of their nuclei.



Since the molecules cannot come closer than distance  $2r$  thus, the excluded volume for a pair of molecules = volume of sphere of radius

$$2r = \frac{4}{3} \pi (2r)^3 = 8 \times \frac{4}{3} \pi r^3$$

$\therefore$  Excluded volume per molecule ( $b$ )

$$= \frac{1}{2} \left( 8 \times \frac{4}{3} \pi r^3 \right) = 4 \times \frac{4}{3} \pi r^3$$

But  $\frac{4}{3} \pi r^3 = V_m$ , i.e., the actual volume of the gas molecule.

$$\therefore b = 4 V_m$$

**13. (a) (i)** The empirical formula of a compound is the chemical formula which expresses the simplest whole number ratio of the atoms of the various elements present in one molecule of the compound.

**(ii)** The molecular formula of a compound is the chemical formula which represents the true formula of its molecule. It expresses the actual number of atoms of various elements present in one molecule of the compound.

Molecular formula =  $n \times$  Empirical formula

Element	%	Atomic mass	Moles	Mole ratio or Atomic ratio	Simplest whole no. ratio
C	57.8	12	$\frac{57.8}{12}$ = 4.82	$\frac{4.82}{2.41}$ = 2	4
H	3.6	1	$\frac{3.6}{1}$ = 3.60	$\frac{3.60}{2.41}$ = 1.49	3
O	38.6	16	$\frac{38.6}{16}$ = 2.41	$\frac{2.41}{2.41}$ = 1	2

$\therefore$  Empirical formula =  $C_4H_3O_2$   
 Empirical formula mass  
 $= (4 \times 12) + (3 \times 1) + (2 \times 16) = 83 \text{ u}$

Molecular mass =  $2 \times$  Vapour density  
 $= 2 \times 83 = 166 \text{ u}$

$$n = \frac{\text{Molecular mass}}{\text{Empirical formula mass}} = \frac{166}{83} = 2$$

Molecular formula =  $n \times$  (empirical formula)  
 $= 2 \times (C_4H_3O_2) = C_8H_6O_4$

**14.** This is mainly because of the greater ionic character of LiF as compared to LiCl. The solubility of a compound in water depends on the balance between lattice enthalpy and hydration enthalpy. Since, fluoride ion is much smaller in size than chloride ion, the lattice enthalpy of LiF is greater than that of LiCl. Also, there is not much difference between the hydration enthalpies of fluoride ion and chloride ion. Thus, the net energy change during the dissolution of LiCl in water is more exothermic than that during the dissolution of LiF in water. Hence, low lattice enthalpy and greater covalent character are the factors making LiCl soluble not only in water, but also in acetone

**15. (i)** The wave function  $\Psi$  for an electron in an atom has no physical significance as such. But the square of the amplitude of the electron wave, *i.e.*,  $\Psi^2$  at any point gives the intensity of the electron wave at that point which in view of Heisenberg's uncertainty principle means probability of finding electrons at that point *i.e.*, electron density at that point.

**(ii)** For *f*-subshell,  $l = 3$ .

For a value of  $n$ , possible values of  $l$  are 0 to  $n - 1$ .

$$l = n - 1 \Rightarrow n = l + 1 = 3 + 1 = 4$$

The lowest value of  $n$  that allows *f*-subshell to exist is 4.

**(iii)** Principal quantum number ( $n$ )

**16. (i)** Due to more stable (half filled) electronic configuration of P, it has greater ionisation enthalpy.

Electronic configuration of S =  $[Ne] 3s^2 3p^4$

Electronic configuration of P =  $[Ne] 3s^2 3p^3$

**(ii)** The ionisation of Al will be smaller than that of Mg due to one electron extra than the stable configuration but smaller than Si due to increase in effective nuclear charge of Si. Hence, the order is  $Na < Mg > Al < Si$ .

**(iii)**  $P_2O_5$  is the most acidic among the given species. As moving across the period acidic character increases and the oxides in higher oxidation state of the element are generally more acidic in nature.

Acidic character :  $MgO < Al_2O_3 < SiO_2 < P_2O_5$

**17.**  $T_{\text{system}} = 130^\circ\text{C} = 130 + 273 \text{ K} = 403 \text{ K}$ ,

$T_{\text{surr}} = 32^\circ\text{C} = 32 + 273 \text{ K} = 305 \text{ K}$

$q_{\text{system}} = -340 \text{ J}$ ,  $q_{\text{surr}} = +340 \text{ J}$

$$\text{(i)} \quad \Delta S_{\text{system}} = \frac{q_{\text{system}}}{T_{\text{system}}} = \frac{-340 \text{ J}}{403 \text{ K}} = -0.84 \text{ J K}^{-1}$$

$$\text{(ii)} \quad \Delta S_{\text{surr}} = \frac{q_{\text{surr}}}{T_{\text{surr}}} = \frac{+340 \text{ J}}{305 \text{ K}} = +1.11 \text{ J K}^{-1}$$

$$\text{(iii)} \quad \Delta S_{\text{total}} \text{ or } \Delta S_{\text{universe}} = \Delta S_{\text{system}} + \Delta S_{\text{surr}} \\ = -0.84 + 1.11 \text{ J K}^{-1} = 0.27 \text{ J K}^{-1}$$

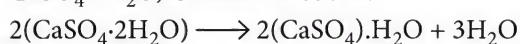
**18. (i)** A porous diaphragm of asbestos is used to keep the  $H_2$  and  $Cl_2$  gases (produced at the electrodes) separated from one another. It also separates the anode and cathode compartment to reduce the possibility of the side reaction occurring to produce sodium hypochlorite, NaOCl.

**(ii) (a)** NaOH is white, translucent, deliquescent crystalline solid which melts at  $591 \text{ K}$ .

**(b)** Its solution is soapy to touch and very corrosive to skin.

**OR**

Plaster of Paris ( $CaSO_4 \cdot 1/2H_2O$ ) is a hemihydrate of calcium sulphate. It is obtained when gypsum,  $CaSO_4 \cdot 2H_2O$ , is heated to  $393 \text{ K}$ .



Above  $393 \text{ K}$ , no water of crystallisation is left and anhydrous calcium sulphate,  $CaSO_4$  is formed. This is known as dead burnt plaster. It has a remarkable property of setting with water. On mixing with an adequate quantity of water it forms a plastic mass that gets into a hard solid in 5 to 15 minutes. Thus, it is used for plaster the fractured bones.

**19. (i) Sublimation** : Camphor sublimates while common salt remains as residue in the china dish.

**(ii) Using separating funnel** : Since the two liquids are immiscible, the technique of solvent extraction with a separating funnel is used. The mixture is thoroughly shaken and the separating funnel is allowed to stand. Kerosene being lighter than water forms the upper layer while water forms the lower layer. The lower water layer is run off and kerosene oil is obtained. It is dried over anhydrous  $CaCl_2$  or  $MgSO_4$  and then distilled to give pure kerosene oil.

**(iii) Distillation under reduced pressure** : Since the b.pt. of a liquid depends upon the pressure acting on it, therefore, a liquid which decomposes as its b.pt. can be purified safely at a lower temperature if the pressure acting on it is reduced.



**20. (i)** The extensive hydrogen bonding in water gives a polymeric structure. This makes the escape of molecules from the liquid more difficult. Therefore, water requires higher temperature to bring its vapour pressure equal to the atmospheric pressure. On the other hand, sulphur being less electronegative, does not form hydrogen bonds. As a result,  $H_2S$  has low boiling point.

**(ii)** Liquids like ether and acetone are highly volatile (high vapour pressure under room temperature conditions). The rate of evaporation depends upon temperature. Therefore, such liquids are kept in cool places (low temperatures) to minimise the loss due to evaporation.

**(iii)** Evaporation causes cooling and the rate of evaporation increases with an increase in the surface area. Since, saucer has a large surface area, hence tea/coffee taken in a saucer cools quickly.

**21.** Rise in temperature of the calorimeter  
 $= 299\text{ K} - 298\text{ K} = 1\text{ K}$

Heat capacity of the calorimeter  $= 20.7\text{ kJ K}^{-1}$

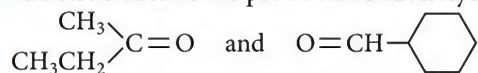
$\therefore$  Heat absorbed by the calorimeter ( $q$ )  $= C_v \times \Delta T$   
 $= (20.7\text{ kJ K}^{-1})(1\text{ K}) = 20.7\text{ kJ}$

This is the heat evolved in the combustion of 1 g of graphite.

$\therefore$  Heat evolved in the combustion of 1 mole of graphite, i.e., 12 g of graphite  $= 20.7 \times 12 = 248.4\text{ kJ mol}^{-1}$

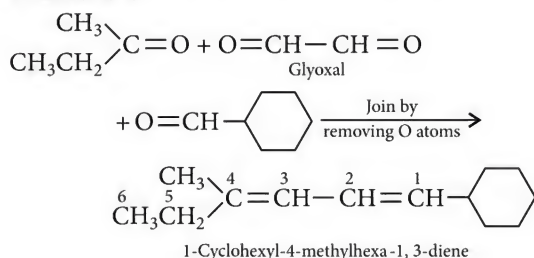
As this is the heat evolved and the vessel is closed, therefore, enthalpy change of the reaction  
 $= -248.4\text{ kJ mol}^{-1}$ .

**22.** The structures of the products of ozonolysis are :



Ethyl methyl ketone ( $C_4H_8O$ )      Cyclohexanecarbaldehyde ( $C_7H_{12}O$ )

Since, the total number of carbon atoms of the two products is 11 (4 + 7) while the molecular formula of the conjugated diene is  $C_{13}H_{22}$ , therefore, the ozonolysis must have also produced another two carbon product. Further, since the given compound ( $C_{13}H_{22}$ ) is an alkadiene, these two carbon products must be glyoxal,  $(\text{CHO})_2$ . On replacing the oxygen atoms from these three products by double bonds, the structure of the alkadiene is



**23. (i)** When smoke released from burning of waste, got mixed with fog during winters, smog is formed.

**(ii)** Two types of smog are :

**(a)** London smog / Sulphurous smog/Classical smog : It is formed due to presence of  $\text{SO}_2$  and humidity in the air.

**(b)** Photochemical smog/Los Angeles smog : It is formed due to photochemical reactions taking place when air contain  $\text{NO}_2$  and hydrocarbons.

**(iii)(a)** Household waste can be managed by using separate garbage bins for biodegradable and non-biodegradable (recyclable) wastes like polythene bags, etc, which choke the sewers.

**(b)** Industrial waste can be managed by (i) recycling waste like glass, plastic etc, (ii) burning and incineration, e.g., plant leaves, etc. (iii) sewage treatment before disposing it off (iv) digesting, i.e., degradation of toxic organic waste by microorganisms (v) dumping of sewage sludge into land.

**(iv)** Concern towards health and environment.

**24. (i)**  $\text{I}_2 < \text{Br}_2 < \text{Cl}_2 < \text{F}_2$

**(ii)** As branching increases, the  $\Delta H^\circ_{\text{comb}}$  decreases (becomes less negative). Thus, the increasing order of heat of combustion is (II) < (I) < (IV) < (III).

**(iii)**  $\text{C}_2\text{H}_2$  (120 pm) <  $\text{C}_2\text{H}_4$  (134 pm) <  $\text{C}_2\text{H}_6$  (154 pm)

**(iv) (a)** As *n*-pentane is linear and *iso*-pentane is not so, *n*-pentane has higher surface area than *iso*-pentane. Hence, the magnitude of van der Waals' force is higher in *n*-pentane. Therefore, it has higher boiling point.

**(b)** Wurtz reaction occurs between two alkyl halides to yield alkane. Methane has only one carbon atom, hence cannot be prepared using Wurtz reaction.

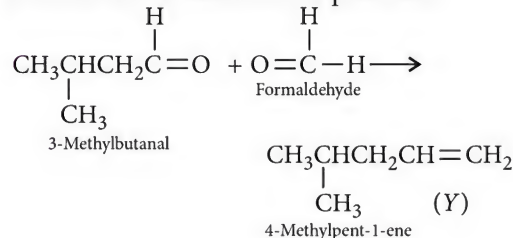
**OR**

**(a)** Alkyne X is  $\text{C}_5\text{H}_8$ . Since it does not react with sodamide or ammoniacal cuprous chloride, the triple bond cannot be terminal.

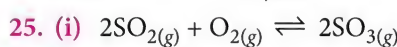
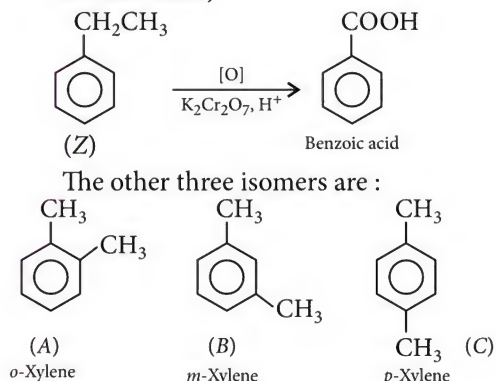
$\therefore$  X is  $\text{CH}_3\text{CH}_2\text{C}\equiv\text{CCH}_3$

Pent-2-yne

**(b)** Hydrocarbon 'Y' is alkene because it decolourises bromine water. From the products of ozonolysis, the structure of alkene can be predicted.



- (c) Since, it does not decolourise bromine water, it is arene. Thus,



For the given reaction,

$$\Delta n_g = n_p - n_r = 2 - 3 = -1$$

$$K_p = 2 \times 10^{10} \text{ bar}^{-1}; K_p = K_c (RT)^{\Delta n_g}$$

$$K_c = \frac{K_p}{(RT)^{\Delta n_g}} = \frac{2 \times 10^{10} \text{ bar}^{-1}}{(0.0831 \text{ L bar K}^{-1} \text{ mol}^{-1} \times 450 \text{ K})^{-1}}$$

$$= 2 \times 10^{10} \times 0.0831 \times 450 \approx 7.48 \times 10^{11} \text{ L mol}^{-1}$$

- (b) For reverse reaction,  $K_c$

$$= \frac{1}{K_c (\text{forward reaction})} = \frac{1}{7.48 \times 10^{11}}$$

$$= 0.134 \times 10^{-11} \text{ L mol}^{-1}$$

- (c) (i) If more  $\text{SO}_2$  is added, rate of forward reaction increases and more  $\text{SO}_3$  will be formed.

- (ii) If pressure is increased, the reaction will shift in forward direction i.e., towards lesser number of moles.

- (iii) Increase in temperature will favour backward reaction.

**OR**

- (i) 1.5 M  $\text{Na}_2\text{CO}_3$  gives  $[\text{CO}_3^{2-}] = 1.5 \text{ M}$

$$K_{sp} \text{ for } \text{Ag}_2\text{CO}_3 = [\text{Ag}^+]^2 [\text{CO}_3^{2-}]$$

$$\therefore [\text{Ag}^+] = \sqrt{\frac{K_{sp} \text{ for } \text{Ag}_2\text{CO}_3}{[\text{CO}_3^{2-}]}} = \sqrt{\frac{8.2 \times 10^{-12}}{1.5}}$$

$$= 2.34 \times 10^{-6} \text{ M}$$

$$K_{sp} \text{ for } \text{AgCl} = [\text{Ag}^+] [\text{Cl}^-]$$

$$= (2.34 \times 10^{-6}) \left( \frac{0.0026}{35.5} \right) = 1.71 \times 10^{-10}$$

- (ii)  $\text{Pb}(\text{OH})_2 \rightleftharpoons \text{Pb}^{2+} + 2\text{OH}^-$

$$\therefore K_{sp} = [\text{Pb}^{2+}] [\text{OH}^-]^2 = s \times (2s)^2 = 4s^3$$

$$= 4 \times (6.7 \times 10^{-6})^3 = 1.20 \times 10^{-15}$$

In a solution with pH = 8,  $[\text{H}^+] = 10^{-8}$  and  $[\text{OH}]^- = 10^{-6}$

$$\therefore 1.2 \times 10^{-15} = [\text{Pb}^{2+}] \times (10^{-6})^2$$

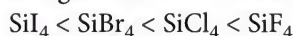
$$\text{or } [\text{Pb}^{2+}] = \frac{1.2 \times 10^{-15}}{(10^{-6})^2} = 1.2 \times 10^{-3} \text{ M}$$

26. (i) (a) The stability of dihalides increases down the group because divalent state becomes more and more stable as we move down the group.



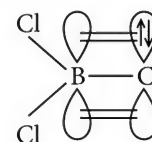
- (b) Basicity of oxides increases down the group as metallic character increases.  $\text{CO} < \text{SiO} < \text{GeO} < \text{SnO} < \text{PbO}$

- (c) Si—X bond strength decreases as the size of the halogen increases. Thus, the correct order is



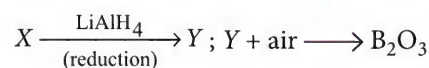
- (ii) (a) Due to small size of boron, there is a dative  $p\pi - p\pi$  bonding takes place between the lone pair on Cl atoms and vacant  $p$ -atomic orbital on B. Hence,  $\text{BCl}_3$  is a monomer.

Due to large size, Al cannot participate in dative  $p\pi - p\pi$  bonding. Therefore, in order to complete the octet,  $\text{AlCl}_3$  dimerizes.

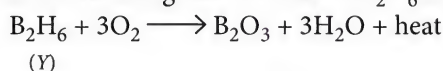


- (b)  $\text{TlCl}$  exist and not  $\text{TlCl}_3$  because as we move down the group, the tendency of  $ns^2$  electron to remain inert increases (inert pair effect). Therefore, only one electron from the  $p$ -atomic orbital participates in the bond formation and hence  $\text{TlCl}_3$  does not exist, only  $\text{TlCl}$  exist.

**OR**



From this we can guess 'Y' must be  $\text{B}_2\text{H}_6$ . As,

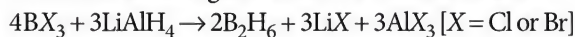


$$\% \text{ of hydrogen in } \text{B}_2\text{H}_6 = \frac{6}{27.62} \times 100 = 21.72\%$$

$$[\text{Mol. wt. of } \text{B}_2\text{H}_6 = 21.62 + 6 = 27.62]$$

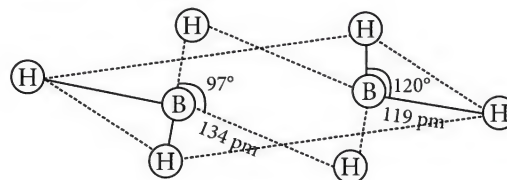
Thus, percentage of hydrogen is 21.72 in  $\text{B}_2\text{H}_6$ .

From this we can guess that X is boron trihalide.



(X) (Y)

Structure of Y ( $\text{B}_2\text{H}_6$ ):



Structure of diborane ( $\text{B}_2\text{H}_6$ )





# MPP-10 MONTHLY Practice Problems

Class XI

This specially designed column enables students to self analyse their extent of understanding of specified chapters. Give yourself four marks for correct answer and deduct one mark for wrong answer. Self check table given at the end will help you to check your readiness.





## Hydrocarbons and Environmental Chemistry

Total Marks : 120

Time Taken : 60 Min.

NEET / AIIMS

Only One Option Correct Type

- On heating sodium propanoate with sodium hydroxide and quick lime, the gas evolved is  
(a)  $C_2H_2$  (b)  $C_2H_6$   
(c)  $CH_4$  (d)  $C_2H_4$
- Toluene on treatment with  $CrO_3$  and  $(CH_3CO)_2O$  followed by hydrolysis with dil. HCl gives  
(a) benzaldehyde (b) benzoic acid  
(c) phenol (d) phenylacetaldehyde.
- Which one of the following statements is not true?  
(a) Clean water would have a BOD value less than 5 ppm.  
(b) Fluoride deficiency in drinking water is harmful. Soluble fluoride is often used to bring its concentration upto 1 ppm.  
(c) When the pH of rain water is higher than 6.5, it is called acid rain.  
(d) Dissolved oxygen (DO) in cold water can reach a concentration upto 10 ppm.
- What are X and Y in the reaction,  
$$C_2H_4 + H_2SO_4 \xrightarrow{80^\circ C} X \xrightarrow[\Delta]{H_2O} Y?$$
  
(a)  $C_2H_6$ ,  $C_2H_5OH$   
(b)  $C_2H_6$ ,  $C_2H_5SH$   
(c)  $C_2H_5OSO_3H$ ,  $C_2H_5OH$   
(d)  $C_2H_2$ ,  $CH_3CHO$
- Consider the following statements regarding compounds which cause global warming. 'X' is a hydrocarbon, 'A' and 'B' are neutral oxides of nitrogen, 'C' is a blue coloured gas and 'D' is released when  $H_2S$  reacts with oxygen. Identify the correct statements about X, A, B, C and D.  
I. 'X' is mainly present in natural gas.  
II. In 'A' and 'B', one is diamagnetic and another one is paramagnetic.  
III. 'C' can be identified by using liquid element of d-block.  
IV. 'D' causes acid rain.  
(a) All are correct (b) I, II, III only  
(c) II, III, IV only (d) I, III, IV only
- 5-Oxohexanal is obtained by ozonolysis of  
(a)   $CH_2CH_3$  (b)   $CH_3$   
(c)   $CH_3$  (d)   $CH_3$
- Which of the following has highest concentration of sulphur dioxide?  
(a) Smoke  
(b) Mist  
(c) Photochemical smog  
(d) Reducing smog
- For the reactions,  $CH_2=CH_2 + H_2 \xrightarrow{Pt, T_1 K} C_2H_6$   
 $CH_2=CH_2 + H_2 \xrightarrow{Ni, T_2 K} C_2H_6$   
the correct relation among the following is  
(a)  $T_1 > T_2$  (b)  $T_2 > T_1$   
(c)  $T_1 = T_2$  (d)  $T_1 = 2T_2$
- Non-ionising radiations with specific biological effects are  
(a) UV radiations (b)  $\beta$ -rays  
(c)  $\gamma$ -rays (d) X-rays.

10. Negative soil pollution is  
 (a) reduction in soil productivity due to erosion and overuse  
 (b) reduction in soil productivity due to addition of pesticides and industrial wastes  
 (c) converting fertile land into barren land by dumping ash, sludge and garbage  
 (d) both (a) and (c).
11. Energy barrier between staggered and eclipsed ethane is  
 (a) 0.6 kcal/mole (b) 3 kcal/mole  
 (c) 12 kcal/mole (d) 16 kcal/mole.
12. In Wurtz reaction, metallic sodium acts as a/an  
 (a) oxidising agent  
 (b) reducing agent  
 (c) dehydrogenating agent  
 (d) dehydrohalogenating agent.

#### Assertion & Reason Type

**Directions :** In the following questions, a statement of assertion is followed by a statement of reason. Mark the correct choice as:

- (a) If both assertion and reason are true and reason is the correct explanation of assertion.  
 (b) If both assertion and reason are true but reason is not the correct explanation of assertion.  
 (c) If assertion is true but reason is false.  
 (d) If both assertion and reason are false.

13. **Assertion :** CO and NO both combine with haemoglobin.

**Reason :** Both have equal affinity for haemoglobin.

14. **Assertion :** For greenhouse effect, presence of green plants is essential.

**Reason :** Chlorophyll of the green plants causes greenhouse effect.

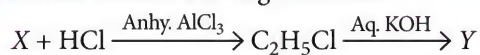
15. **Assertion :** HCl does not add to unsymmetrical alkene by free radical mechanism.

**Reason :** H — Cl bond is too strong to break into free radical.

#### JEE MAIN / JEE ADVANCED

##### Only One Option Correct Type

16. Consider the following reactions :



Y can be converted to X on heating with \_\_\_\_\_ at \_\_\_\_\_ temperature.

- (a)  $\text{Al}_2\text{O}_3$ ,  $350^\circ\text{C}$   
 (b) Cu,  $300^\circ\text{C}$

- (c)  $\text{Ca}(\text{OH})_2 + \text{CaOCl}_2$ ,  $60^\circ\text{C}$   
 (d)  $\text{NaOH}/\text{I}_2$ ,  $60^\circ\text{C}$

17. When  $R - C \equiv CH$  is treated with cuprous ions in ammoniacal medium, product formed is

- (a)  $R - C \equiv C - \text{Cu}$  (b)  $\text{Cu} - C \equiv CH$   
 (c)  $\text{CuC} \equiv \text{CCu}$  (d)  $R - C \equiv C - R$

18. 10 mL of water requires 1.47 mg of  $\text{K}_2\text{Cr}_2\text{O}_7$  (mol. wt. = 294) for oxidation of dissolved organic matter in presence of  $\text{H}_2\text{SO}_4$ . C.O.D. is

- (a) 2.44 ppm (b) 24 ppm  
 (c) 32 ppm (d) 1.6 ppm

19. B.O.D. values of four samples of water I, II, III and IV are given below :

- I. 160 ppm II. 35 ppm  
 III. 180 ppm IV. 25 ppm

The decreasing order of extent of pollution in water is

- (a)  $\text{III} > \text{I} > \text{IV} > \text{II}$  (b)  $\text{IV} > \text{II} > \text{I} > \text{III}$   
 (c)  $\text{III} > \text{I} > \text{II} > \text{IV}$  (d)  $\text{IV} > \text{I} > \text{II} > \text{III}$

#### More than One Options Correct Type

20. Which of the following pollutants is emitted during volcanic eruptions?

- (a)  $\text{SO}_2$  (b)  $\text{H}_2\text{S}$   
 (c) Hydrocarbons (d) CO

21. Which of the following is not responsible for eutrophication of lakes?

- (a)  $\text{Cl}^-$  (b)  $\text{Ca}^{2+}$   
 (c)  $\text{ClO}_4^-$  (d)  $\text{PO}_4^{3-}$

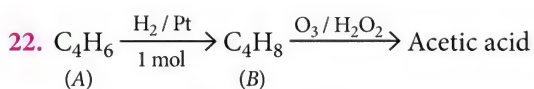
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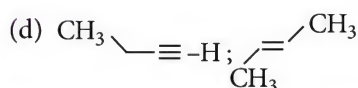
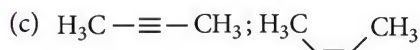
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(A) and (B) are respectively



23. Which of the following is the correct match?

- (a)  $Be_2C + H_2O \rightarrow$  Marsh gas  
 (b)  $Al_4C_3 + H_2O \rightarrow$  Component of CNG  
 (c)  $CaC_2 + H_2O \rightarrow$  Used for welding purpose with  $O_2$  gas  
 (d)  $Mg_2C_3 + H_2O \rightarrow$  Used as a rocket fuel

### Integer Answer Type

24. How many structures are possible for  $C_5H_8$  with one triple bond?

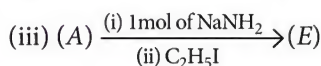
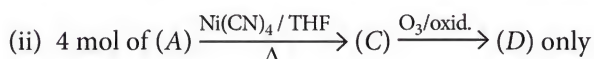
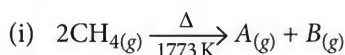
25. How many acids given below are present in acid rain?  
 $H_2CO_3$ ,  $HClO_4$ ,  $H_2SO_4$ ,  $HNO_3$ ,  $HCl$ ,  $H_3PO_4$ ,  $CH_3COOH$

26. How many compounds are formed upon the ozonolysis followed by hydrolysis of the following triyne?



### Comprehension Type

In the following sequence of reactions, the products (A) to (E) are formed :



27. Compound 'D' is

- (a) glyoxal (b) glycol  
 (c) oxalic acid (d) methylglyoxal.

28. Compound 'E' is

- (a) propyne (b) butyne  
 (c) but-2-yne (d) ethyne.

### Matrix Match Type

29. Match the processes given in Column I with reagents mentioned in Column II and choose the correct answer using the codes given below :

Column I		Column II	
P.	Dehydrohalogenation	1.	$O_2/\Delta$ , Ag catalyst
Q.	Dehydration	2.	Alc. KOH
R.	Unsaturation	3.	Conc. $H_2SO_4/170^\circ C$
S.	Epoxidation	4.	$Br_2$ -water
P	Q	R	S
(a)	3	2	4
(b)	2	3	4
(c)	4	1	3
(d)	3	1	2

30. Match the Column I with Column II and choose the correct answer using the codes given below :

Column I		Column II	
P.	Fluorides	1.	Photosynthesis is affected
Q.	$SO_2$	2.	Eutrophication
R.	Cyanides, $CO_2$ , $H_2S$	3.	Consumes dissolved oxygen
S.	Nitrate and sulphate nutrients	4.	Bad effects on teeth and bones
		5.	pH of water changes and becomes toxic to aquatic animals
P	Q	R	S
(a)	1	2	3
(b)	4	2	3
(c)	4	1	5
(d)	4	1	2



Keys are published in this issue. Search now! ☺

## SELF CHECK

No. of questions attempted .....  
 No. of questions correct .....  
 Marks scored in percentage .....

### Check your score! If your score is

> 90%	EXCELLENT WORK !	You are well prepared to take the challenge of final exam.
90-75%	GOOD WORK !	You can score good in the final exam.
74-60%	SATISFACTORY !	You need to score more next time.
< 60%	NOT SATISFACTORY !	Revise thoroughly and strengthen your concepts.

# NEET | JEE ESSENTIALS

Class  
XII

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## Unit 8

## Polymers | Chemistry in Everyday Life

### POLYMERS

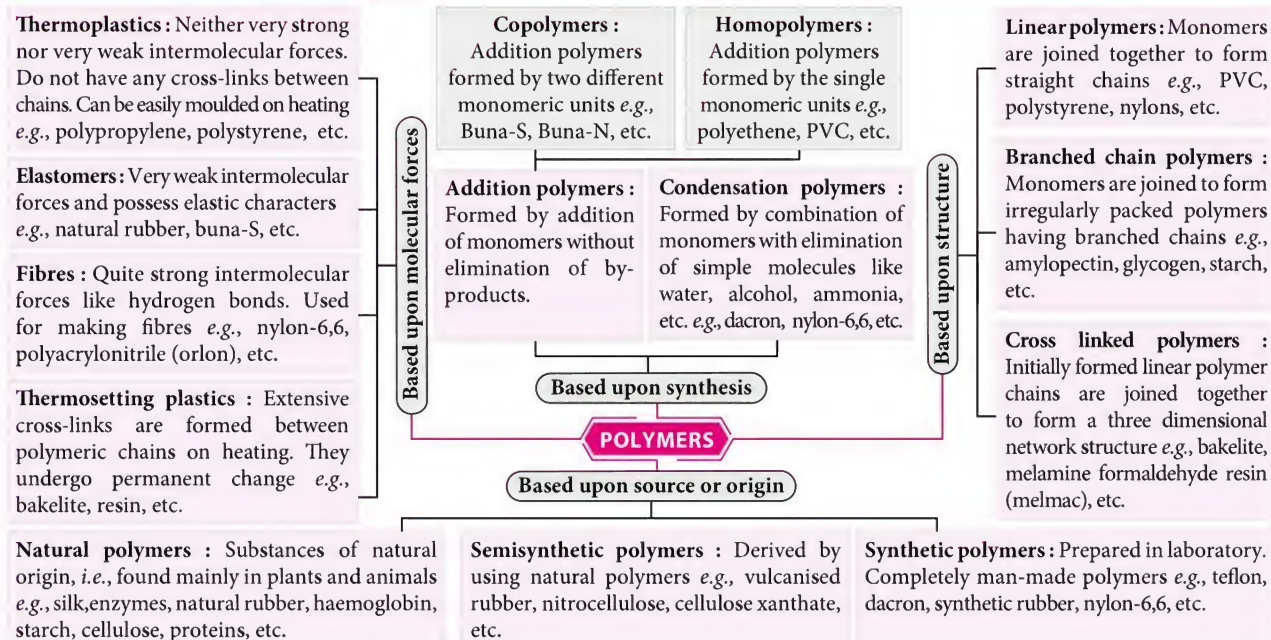
#### INTRODUCTION

- Polymers are large molecules having high molecular mass ( $10^3 - 10^7$  u) formed by chemical combination of a large number of relatively smaller molecules

known as monomers.

- Monomers are linked to each other by covalent bonds and referred as polymerisation.
- All polymers are macromolecules but all macromolecules are not polymers.

#### CLASSIFICATION OF POLYMERS







## SOME IMPORTANT ADDITION AND CONDENSATION POLYMERS

### Addition Polymers

#### LDPE

- Highly branched polymer.
- Low density ( $0.92 \text{ g/cm}^3$ ), low melting point (384 K).
- Transparent, moderate tensile strength.
- Chemically inert, tough but flexible.
- Used for packaging, insulation and manufacturing squeeze bottles, pipes, toys, etc.

#### HDPE

- Linear molecules, closely packed.
- High density ( $0.97 \text{ g/cm}^3$ ), high melting point (403 K).
- Translucent
- Chemically inert, quite harder, greater tensile strength.
- Used for manufacturing containers, housewares and pipes, etc.

#### Teflon

- Chemically inert and resistant to attack by corrosive reagents.
- Teflon coating undergoes decomposition at temperature above  $300^\circ\text{C}$ .
- Used for non-stick surface coated utensils.

### Condensation Polymers

#### Nylon 6,6

- Prepared by the condensation polymerisation of hexamethylenediamine with adipic acid under high pressure and at high temperature.
- It is used in textile industry.

#### Bakelite

- Infusible solid mass.
- Cross-linking polymer.
- Formed when novolac undergoes heating with formaldehyde.
- Used for handling of various utensils.

## RUBBER

### Natural rubber

It is a linear 1, 4-addition polymer of isoprene and have *cis*-configuration of all double bonds thus, known as *cis*-1, 4-polyisoprene.

- It is insoluble in water, dilute acids and alkalies but soluble in organic solvents like benzene, petrol, etc.
- It has low elasticity and tensile strength.
- It shows high water absorption capacity.
- It has weak intermolecular van der Waals' forces.

### Vulcanisation of rubber

It is the process of heating natural rubber with sulphur at a temperature of 373-415 K. Sulphur cross-links makes the rubber hard, tough with greater tensile strength.

- On vulcanisation, sulphur forms cross-links at the reactive site of double bonds and thus, the rubber get stiffened.
- Some additives like carbon black, zinc oxide, etc. are used to improve wearing properties.

### Synthetic rubber

It is obtained by polymerising certain organic compounds which may have properties similar to rubber and some additional desirable properties. These are also vulcanised. For example, neoprene, styrene butadiene rubber (SBR), thiokol, silicones, polyurethane rubber.

The *trans*-isomer of polyisoprene *i.e.* *gutta percha* is synthetic rubber and considered to be non-elastic.

### Neoprene

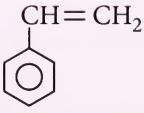
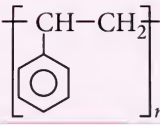
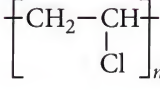
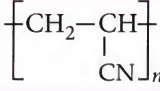
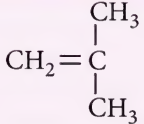
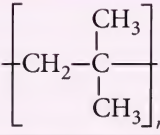
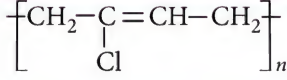
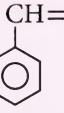
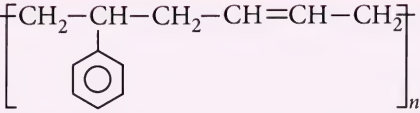
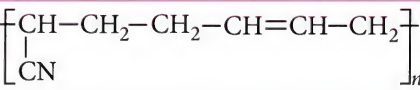
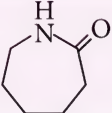
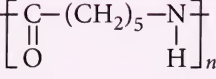
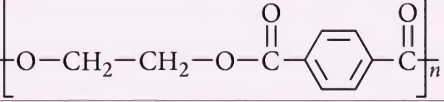
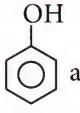
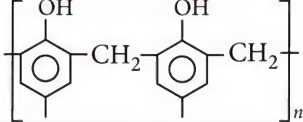
It is a polymer of chloroprene. It is superior due to its stability to aerial oxidation and its resistance to vegetables and mineral oils.

### Nitrile rubber or Buna-N

It is a polymer of buta-1,3-diene and acrylonitrile. It is resistant to the action of petrol, lubricating oil and organic solvents, etc.



## SOME IMPORTANT POLYMERS

Polymer	Structure of monomer(s)	Structure of polymer	Uses
Polythene	$\text{CH}_2=\text{CH}_2$	$\text{-(CH}_2\text{-CH}_2\text{)}_n$	As insulator, packing material, household and laboratory ware.
Polystyrene			As insulator, wrapping material, household articles and toys maker.
Polyvinyl chloride (PVC)	$\text{CH}_2=\text{CHCl}$		In manufacture of raincoats, hand bags, leather clothes and vinyl flooring.
Polytetrafluoro-ethylene (PTFE) or Teflon	$\text{CF}_2=\text{CF}_2$	$\text{-(CF}_2\text{-CF}_2\text{)}_n$	As lubricant, insulator and making cooking wares.
Polyacrylonitrile (PAN) or Orlon	$\text{CH}_2=\text{CH-CN}$		In making synthetic fibres and wool.
Butyl rubber			Used in place of natural rubber in industry.
Neoprene	$\text{CH}_2=\text{C}(\text{Cl})\text{-CH=CH}_2$		As insulator, making conveyor belts and printing rollers.
Styrene Butadiene Rubber (SBR) or (Buna-S)	 and $\text{CH}_2=\text{CH-CH=CH}_2$		In making automobile tyres, floor tiles, cable insulation and footwear.
Nitrile rubber (Buna-N)	$\text{CH}_2=\text{CHCN}$ and $\text{CH}_2=\text{CH-CH=CH}_2$		In making oil seals, hose-pipes and tank linings.
Nylon-6 (Perlon-L)			In making carpets, ropes and tyre cords.
Nylon-6, 6	$\text{HOOC-(CH}_2\text{)}_4\text{-COOH}$ and $\text{H}_2\text{N-(CH}_2\text{)}_6\text{-NH}_2$	$\text{-(CO-(CH}_2\text{)}_4\text{-CONH-(CH}_2\text{)}_6\text{-NH)}_n$	Synthetic fibres, fishing nets, ropes and tyre industries.
Terylene (Dacron)	$\text{HOOC-C}_6\text{H}_4\text{-COOH}$ and $\text{HOCH}_2\text{CH}_2\text{OH}$		Synthetic fibres, safety belts, tyre cords and tents.
Bakelite (Phenol-formaldehyde resin)	 and $\text{HCHO}$		In making gears, protective coatings and electric fittings.

## CHEMICALS IN MEDICINES

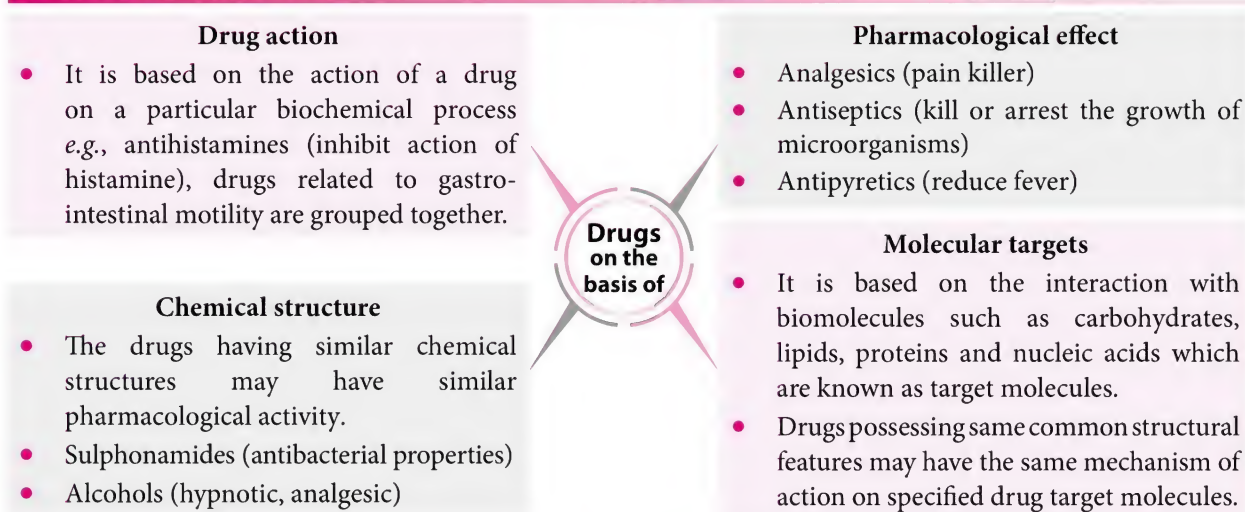
- Drugs are the chemicals of low molecular masses and interact with macromolecular targets to produce biological response.
- The chemicals of therapeutic biological response which are used in diagnosis, prevention and treatment of diseases are known as medicines.
- Use of chemicals for therapeutic effect is known as chemotherapy.

- Therapeutic index (TI) : It is the ratio of maximum tolerated dose, MTD (*i.e.* amount of drug necessary to kill the microorganism) to maximum curative dose, MCD (*i.e.* amount of drug required to cure the disease).]

$$TI = \frac{\text{Maximum tolerated dose (MTD)}}{\text{Maximum curative dose (MCD)}}$$

Higher the therapeutic index, safer the drug will be.

## CLASSIFICATION OF DRUGS



## DRUG TARGET INTERACTION

### Enzymes as Drug Target

**Catalytic action of enzymes** : Proteins which perform the role of biological catalysts in the body are called enzymes. Enzymes perform two major functions in their catalytic activity :

- To hold the substrate for a chemical reaction.
- To provide functional groups that will attack the substrate and carry out chemical reactions.

**Drug-enzyme interaction** : Drugs that can inhibit the catalytic activity of the enzyme are called enzyme inhibitors.

- The drugs that compete with the natural substrate for their attachment on the active sites of enzymes are called competitive inhibitors.

- Some drugs bind to a different site of enzyme other than active site are called allosteric site which changes the shape of active site.

### Receptors as Drug Target

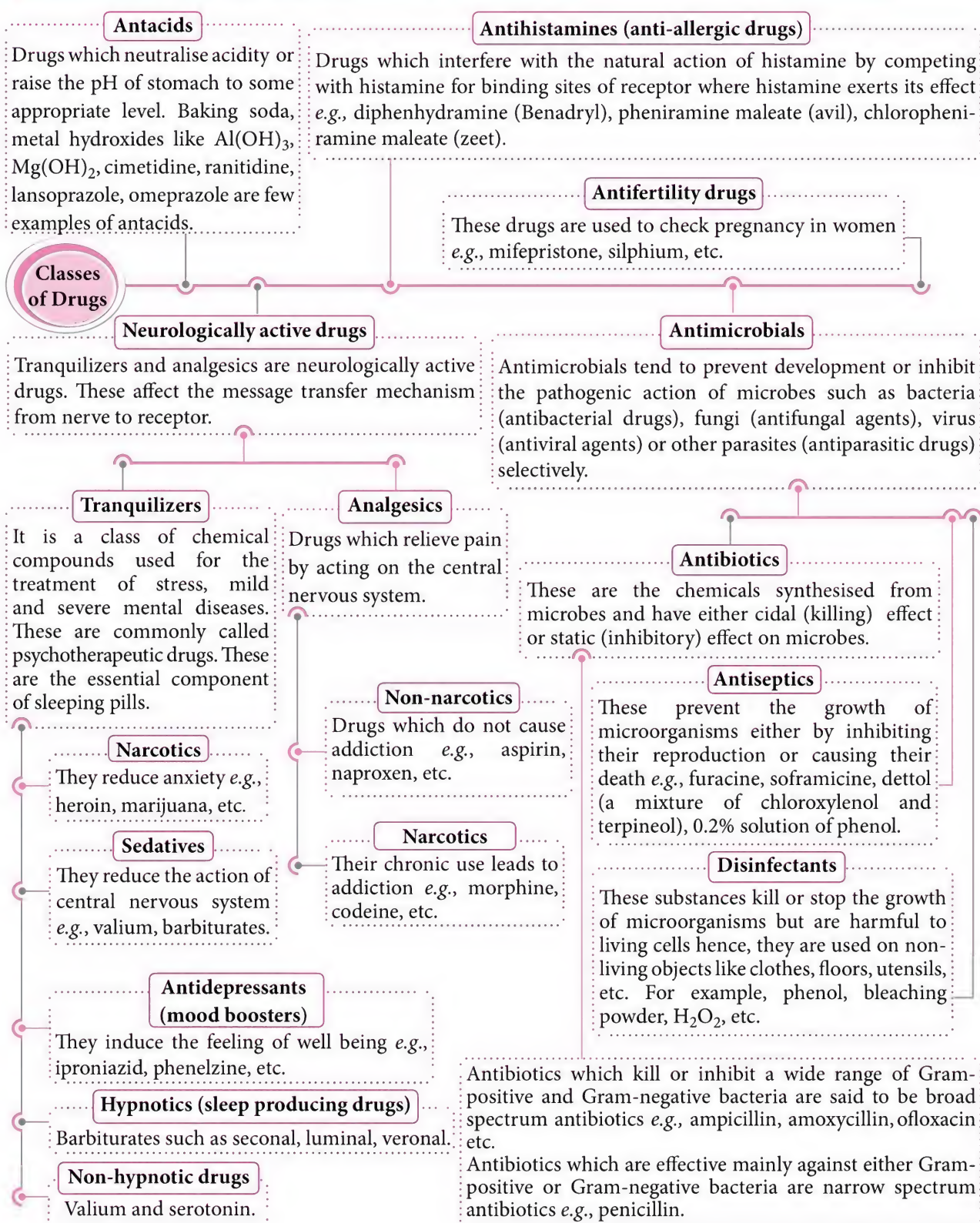
- Proteins which transmit communication to the different parts of the body are called receptors. Receptor proteins are embedded in the cell membrane and receptor changes its shape to accommodate a chemical messenger which brings about transfer of message into the cell.

#### Drugs interact with receptors in two ways :

- Drugs bind to their receptor sites and inhibit its natural function (**antagonists**). These are useful when blocking of message is required.
- Some drugs mimic the natural messenger by switching on the receptor (**agonists**). These are useful when there is lack of natural chemical messenger.



## THERAPEUTIC ACTION OF DIFFERENT CLASSES OF DRUGS



## CHEMICALS IN FOOD

- Chemicals which are added to food for their preservation or enhancing their appeal, flavour or nutritive value in them, etc. are known as food additives.

### Food Preservatives

- These are the chemical substances which are added to the food materials to prevent their spoilage due to microbial growth and to retain their nutritive value for long periods.
- The most common preservative used is sodium benzoate ( $C_6H_5COONa$ ).
- Certain food preservatives such as BHA and BHT used for edible oils also act as antioxidants.

### Artificial Sweetening Agents

- These are chemical compounds which give sweetening effect to the food and enhance its odour and flavour.

Artificial Sweetener	Sweetness Value in Comparison to Cane Sugar
Aspartame	100
Saccharin	550
Sucralose	600
Alitame	2000

### Antioxidants

- These are the chemical substances which prevent oxidation and subsequent spoilage of the food by retarding the action of oxygen on food. They act as sacrificial materials as they are more reactive towards oxygen than the materials they are protecting.

## CLEANSING AGENTS

### Soaps

- These are sodium or potassium salts of higher fatty acids (with 12-18 carbon atoms) e.g., salts of  $C_{15}H_{31}COOH$  (palmitic acid),  $C_{17}H_{33}COOH$  (stearic acid),  $C_{17}H_{33}COOH$  (oleic acid),  $C_{18}H_{35}COOH$  (linoleic acid), etc.

### Synthetic Detergents

- These are sodium salts of long chain alkyl hydrogen sulphates or the sodium salts of long chain benzene sulphonc acids.

**Cationic detergents** : Trimethylstearylammmonium chloride,  $CH_3(CH_2)_{17}N^+(CH_3)_3Cl^-$

**Anionic detergents** : Sodium lauryl sulphate,  $C_{12}H_{25}OSO_3^-Na^+$

**Non-ionic detergents** : Polyethylene glycol stearate,  $CH_3(CH_2)_{17}COO(CH_2CH_2O)_nCH_2CH_2OH$

### Advantages of Synthetic Detergents over Soaps

- They can be used in hard water, in acidic medium while soaps get precipitated.
- They are more soluble in water and thus, form lather more easily.
- They are stronger cleansing agents than soaps as they decrease the surface tension to greater extent.

### Cleansing Action of Soaps and Detergents

- The hydrophilic carboxylate group interact with water molecules while the hydrophobic long non-polar hydrocarbon chain does not interact.
- The hydrocarbon chains cluster together forming structure called micelles.
- In the micelles, the carboxylate groups form a negatively-charged spherical surface, with the hydrocarbon chains inside the sphere.
- Being negatively charged, soap micelles repel each other and remain dispersed in water.

## INFOSHOTS

### Polymers in Drug Delivery !

Polymer-based drug delivery systems have been extensively explored as promising nanoscale approaches in cancer nanotechnology research. Well-designed nanocarriers can improve the delivery of small drug therapeutics to targeted tumors in chemotherapy, thus minimizing undesired side effects and maximising drug efficacy common to small drugs. Despite these tremendous advances including several promising self-assembled nanocarriers in clinical studies, current and future research requires more precise control over the properties.



# SPEED PRACTICE

- Which of the following sets of reactants is used for preparation of paracetamol from phenol?  
(a)  $\text{HNO}_3$ ,  $\text{H}_2/\text{Pd}$ ,  $(\text{CH}_3\text{CO})_2\text{O}$   
(b)  $\text{H}_2\text{SO}_4$ ,  $\text{H}_2/\text{Pd}$ ,  $(\text{CH}_3\text{CO})_2\text{O}$   
(c)  $\text{C}_6\text{H}_5\text{N}_2\text{Cl}$ ,  $\text{SnCl}_2/\text{HCl}$ ,  $(\text{CH}_3\text{CO})_2\text{O}$   
(d)  $\text{Br}_2/\text{H}_2\text{O}$ ,  $\text{Zn}/\text{HCl}$ ,  $(\text{CH}_3\text{CO})_2\text{O}$
- Which one of the following is an example of a thermosetting polymer?  
(a) Neoprene  
(b) Terylene  
(c) Urea-formaldehyde resin  
(d) Polyvinyl chloride
- A combination of nitrocellulose and nitroglycerine is a propellant of which of the following types?  
(a) Double base propellant  
(b) Biliquid propellant  
(c) Hybrid propellant  
(d) None of the above
- The pupils of eyes are dilated with a very dilute solution of an alkaloid which is  
(a) adrenaline (b) atropine  
(c) equanil (d) ephedrine.
- Which of the following acts as a chain transfer agent in vinyl polymerization?  
(a) *t*-Butyl peroxide (b) Carbon tetrachloride  
(c) Diphenylamine (d) Phenol
- Mixture of chloroxylenol and terpineol acts as an  
(a) antiseptic (b) antipyretic  
(c) antibiotic (d) analgesic.  
[NEET 2017]
- Propene polymerises in isotactic, syndiotactic, and atactic forms, while vinylidene chloride ( $\text{CH}_2=\text{CCl}_2$ ) does not, this is because  
(a) polypropene is chiral but vinylidene chloride is not  
(b) polypropene contains conjugated double bonds but vinylidene chloride does not  
(c) polypropene is reactive but vinylidene chloride is inert  
(d) all of the above.
- Sodium metabisulphite is used in preserving squashes and other mildly acidic foods because  
(a) sodium salt has preservative action  
(b) sulphurous acid is formed which inhibits the growth of bacteria and germs  
(c) sodium metabisulphite prevents oxidation  
(d) sodium metabisulphite is not influenced by acid.
- Which of the following is condensation polymer?  
(a) Nylon-6 (b) Glyptal  
(c) Both (a) and (b) (d) None of these
- The reason for 'drug induced poisoning' is  
(a) binding reversibly at the active site of the enzyme  
(b) bringing conformational changes in the binding site of enzyme  
(c) binding at the allosteric sites of the enzyme  
(d) binding irreversibly to the active site of the enzyme.  
[JEE Main Online 2017]
- When condensation product of hexamethylene-diamine and adipic acid is heated to 553 K in an atmosphere of nitrogen for about 4-5 hours, the product obtained is  
(a) solid polymer of nylon-6, 6  
(b) liquid polymer of nylon-6, 6  
(c) gaseous polymer of nylon-6, 6  
(d) liquid polymer of nylon-6.
- Among cellulose, polyvinyl chloride, nylon and natural rubber, the polymer in which the intermolecular forces of attraction are weakest, is  
(a) nylon  
(b) polyvinyl chloride  
(c) cellulose  
(d) natural rubber.
- The turbidity of a polymer solution measures  
(a) the light scattered by solution  
(b) the light absorbed by solution  
(c) the light transmitted by solution  
(d) none of the above.

14. Which of the following is a biodegradable polymer?

- (a)  $\left[ \text{HN}-(\text{CH}_2)_6\text{NHCO}-(\text{CH}_2)_4-\overset{\text{O}}{\parallel}{\text{C}} \right]_n$
- (b)  $\left[ \text{HN}-(\text{CH}_2)_5\text{CONH}-\text{CH}_2-\overset{\text{O}}{\parallel}{\text{C}} \right]_n$
- (c)  $\left[ \text{HN}-(\text{CH}_2)_5-\overset{\text{O}}{\parallel}{\text{C}} \right]_n$
- (d)  $\left[ \overset{\text{O}}{\parallel}{\text{C}}-\text{C}_6\text{H}_4-\text{COO}-(\text{CH}_2)_2-\text{O} \right]_n$

[JEE Main Online 2017]

15. The catalyst used for olefin polymerization is

- (a) Ziegler—Natta catalyst  
(b) Wilkinson catalyst  
(c) raney nickel catalyst  
(d) merrified resin.

16. Detergents are prepared by the action of  $\text{H}_2\text{SO}_4$  followed by neutralisation by starting with

- (a) methanol (b) lauryl alcohol  
(c) cyclohexanol (d) *p*-nitrophenol.

17. Beckmann rearrangement is involved in the synthesis of which of the following polymers?

- (a) PAN (b) Nylon-6, 10  
(c) Nylon-6 (d) Melamine

18. Assuming the sweetness of the cane sugar to be 10, the sweetness of glucose is

- (a) 12 (b) 7.5 (c) 15 (d) 5

19. Which of the following alkenes is most reactive towards cationic polymerization?

- (a)  $\text{CH}_2=\text{CHCH}_3$  (b)  $\text{CH}_2=\text{CHCl}$   
(c)  $\text{CH}_2=\text{CHC}_6\text{H}_5$  (d)  $\text{CH}_2=\text{CHCOOCH}_3$

20. A polymer which has better light transmission properties than glass, is

- (a) perspex (b) bakelite  
(c) Buna-S (d) polyethyl acrylate.

21. The formation of which of the following polymers involves hydrolysis reaction?

- (a) Nylon-6, 6 (b) Terylene  
(c) Nylon-6 (d) Bakelite

[JEE Main 2017]

22. The monomer used for the manufacture of PVC is obtained by the addition of

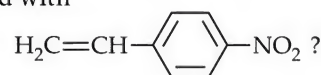
- (a)  $\text{HCl}$  to acetylene in presence of  $\text{Hg}^{2+}$  salts  
(b)  $\text{Cl}_2$  to acetylene  
(c)  $\text{HCl}$  to ethylene  
(d)  $\text{Cl}_2$  to ethylene.

23. Which of the following organic compounds polymerizes to form the polyester dacron?

- (a) Propylene and *para*-  $\text{HO}-(\text{C}_6\text{H}_4)-\text{OH}$   
(b) Benzoic acid and ethanol  
(c) Terephthalic acid and ethylene glycol  
(d) Benzoic acid and *para*-  $\text{HO}-(\text{C}_6\text{H}_4)-\text{OH}$

[NEET 2014]

24. Although styrene undergoes both cationic and anionic polymerisation, one method is always preferred with substituted styrenes. Which method is preferred with



- (a) Radical polymerisation  
(b) Cationic polymerisation  
(c) Anionic polymerisation  
(d) None of the above

25. IUPAC name of alizarin is

- (a) 2,3-dihydroxyphenanthraquinone  
(b) 1,4-dihydroxyanthraquinone  
(c) 1,2-dihydroxyphenanthraquinone  
(d) 1,2-dihydroxyanthraquinone.

26. Polymerisation of propene using Ziegler—Natta catalyst is advantageous over free radical polymerisation because

- (a) it can lead to living polymers via anionic polymerisation  
(b) it permits step-growth polymerisation resulting in a highly cross-linked polymer  
(c) it gives highly branched polymer with a high degree of crystallinity  
(d) it gives linear polymer molecules, permitting stereochemical control.

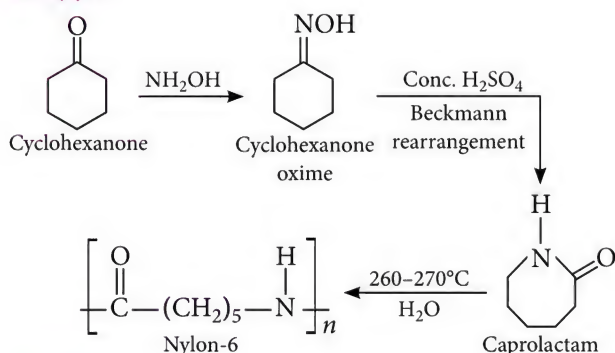
27. Which one of the following statements is not true?

- (a) Buna-S is a copolymer of butadiene and styrene.  
(b) Natural rubber is a 1,4-polymer of isoprene.  
(c) In vulcanisation, the formation of sulphur bridges between different chains make rubber harder and stronger.  
(d) Natural rubber has *trans*-configuration at every double bond.



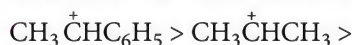


17. (c):



18. (b): Sweetness of glucose is approximately 75% of cane sugar. If sweetness of cane sugar is 10, then sweetness of glucose is  $10 \times \frac{75}{100} = 7.5$

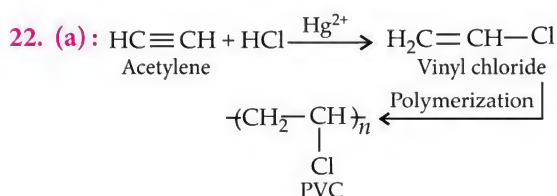
19. (c): In cationic polymerization, carbocations are formed. Greater the stability of the carbocation, more reactive is the alkene. Since the stability of the intermediate carbocations follows the order:



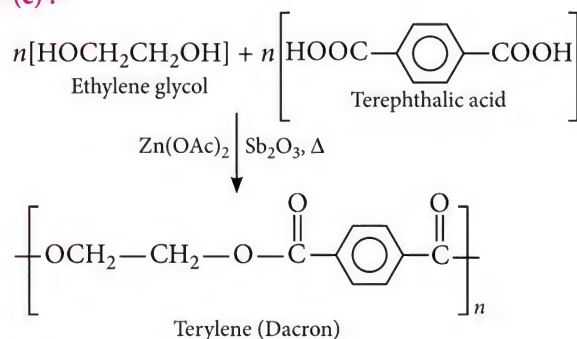
therefore, reactivity decreases in the same order. Thus, styrene is most reactive.

20. (a)

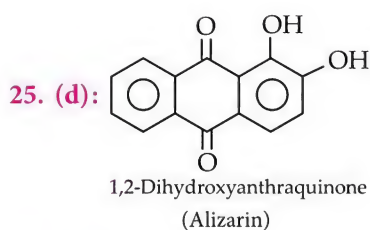
21. (c): Nylon-6 is prepared when caprolactam is hydrolysed to produce caproic acid which further undergoes condensation to produce nylon-6.



23. (c):

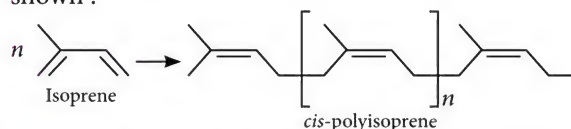


24. (c)



26. (d)

27. (d): Natural rubber is *cis*-1,4-polyisoprene and has only *cis*-configuration about the double bond as shown:



28. (d): Teflon is used to make non-stick cookwares.

29. (c): From the reactions given, it is clear that 1 mol of  $\text{CaC}_2$  gives 1 mole of ethene.

Molecular weight of  $\text{CaC}_2 = 40 + 24 = 64$

64 kg of  $\text{CaC}_2$  gives 28 kg of ethene

20 kg of  $\text{CaC}_2$  will give  $\frac{28}{64} \times 20 = 8.75$  kg of ethene

8.75 kg of ethene will give 8.75 kg of polyethene only.

30. (a): Dilute solutions of boric acid and hydrogen peroxide are weak antiseptics.



CLASS XII

# ACE

## YOUR WAY

CBSE

### Practice Paper 2018



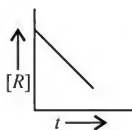
Time Allowed : 3 hours  
Maximum Marks : 70

#### GENERAL INSTRUCTIONS

- All questions are compulsory.
- Question 1 of every short answer question and carry 1 mark each.
- Question 4 of every short answer question and carry 2 marks each.
- Question 1 of each so short answer question and carry 3 marks each.
- Question 2 of each short answer question and carry 4 marks.
- Question 3 of each long answer question and carry 5 marks each.
- Use of calculator is not allowed.

Exam on  
13<sup>th</sup> March  
2018

- What are biocatalysts? Give an example.
- Complete the following chemical equation :  
 $\text{Cr}_2\text{O}_7^{2-}(\text{aq}) + \text{H}_2\text{S}(\text{g}) + \text{H}^+(\text{aq}) \longrightarrow$
- State two advantages of  $\text{H}_2\text{-O}_2$  fuel cell over ordinary cell.
- Why is it necessary to purify the colloidal solution?
- Express the relation between conductivity and molar conductivity of a solution.
- For a chemical reaction,  $R \rightarrow P$ , the variation in the concentration  $[R]$  vs. time ( $t$ ) is given then  
(i) predict the order of the reaction.  
(ii) what is the slope of the curve?  
(iii) Give one example of such type of reactions.



OR

- For a reaction,  $A + B \rightarrow \text{product}$ , the rate law is given by,  $\text{rate} = k[A]^1[B]^2$ . What is the order of the reaction?
- Write the integrated rate expression and unit of rate constant 'k' for the first order reaction.

- Mention the reactions occurring at (i) anode, (ii) cathode, during working of a mercury cell. Why does the cell potential of a mercury cell remain constant during its operation?
- How is gold extracted from its ore?
- (i) How is the magnetic moment of a species related to the number of unpaired electrons?  
(ii) Calculate the magnetic moment of a divalent ion in aqueous solution if its atomic number is 25.
- The molecular shape of  $[\text{Ni}(\text{CO})_4]$  is not the same as that of  $[\text{Ni}(\text{CN})_4]^{2-}$ . Give reason.
- Compound (A) with molecular formula,  $\text{C}_4\text{H}_9\text{Br}$  was treated with aq. KOH solution. The rate of this reaction depends upon the concentration of the compound 'A' only. When another optically active isomer 'B' of this compound was treated with aq. KOH solution, the rate of reaction was found to be dependent on the concentration of compound and KOH both.  
(i) Write down the structural formula of both compounds 'A' and 'B'.

- (ii) Out of these two compounds, which one will be converted to the product with inverted configuration?
12. Name the reagents which are used in the following conversions and write the complete equations for each :
- A primary alcohol to an aldehyde
  - Butan-2-one to butan-2-ol
  - Phenol to 2, 4, 6-tribromophenol.
13. Write the structures of compounds A, B and C in each of the following reactions :
- $\text{C}_6\text{H}_5\text{Br} \xrightarrow{\text{Mg/dry ether}} \text{A} \xrightarrow[\text{(b) H}_3\text{O}^+]{\text{(a) CO}_2(\text{g})} \text{B} \xrightarrow{\text{PCl}_5} \text{C}$
  - $\text{CH}_3\text{CN} \xrightarrow[\text{(b) H}_3\text{O}^+]{\text{(a) SnCl}_2/\text{HCl}} \text{A} \xrightarrow{\text{dil. NaOH}} \text{B} \xrightarrow{\Delta} \text{C}$
14. State differences between the following pairs :
- $\alpha$ -Helix structure and  $\beta$ -pleated sheet structure.
  - Primary and secondary structures of proteins.
  - Enzymes and co-enzymes.
15. Draw the structures of given polymers and their monomers :
- Polythene
  - Polystyrene
  - PVC
- Also write their uses.
16. A sample of ferrous oxide has actual formula,  $\text{Fe}_{0.93}\text{O}_{1.00}$ . In this sample, what fraction of metal ions are  $\text{Fe}^{2+}$ ? What type of non-stoichiometric defect is present in this sample?
- OR**
- "Stability of a crystal is related to the magnitude of its melting point." How?
  - How would you account for the following :
    - Frenkel defects are not found in alkali metal halides?
    - Schottky defects lower the density of related solids?
17. (i) Explain the following :  
In the structure of  $\text{HNO}_3$  molecule, the N—O bond (121 pm) is shorter than N—OH bond (140 pm).
- (ii) Complete the following equation :  
 $\text{P}_4 + \text{H}_2\text{O} \longrightarrow$
- (iii) Name the two most important allotropes of sulphur. Which one of the two is stable at room temperature? What happens when the stable form is heated about 370 K?
18. (i) What do you mean by activity and selectivity of catalysts?
- (ii) On the basis of Hardy—Schulze rule, explain why the coagulating power of phosphate is higher than chloride.
19. Write the mechanism of esterification of carboxylic acids.
20. (i) Write the distinction tests for
- ethyl alcohol and 2-propanol
  - acetaldehyde and acetone.
- (ii) What is absolute alcohol?
21. The electrical resistance of a column of 0.05 M NaOH solution of diameter 1 cm and length 50 cm is  $5.5 \times 10^3$  ohm. Calculate its resistivity, conductivity and molar conductivity.
22. In a pseudo first order hydrolysis of ester in water, the following results are obtained :
- |                     |      |      |      |       |
|---------------------|------|------|------|-------|
| <b>t in seconds</b> | 0    | 30   | 60   | 90    |
| <b>[Ester] in M</b> | 0.55 | 0.31 | 0.17 | 0.085 |
- Calculate the average rate of reaction between the time interval 30 to 60 seconds.
  - Calculate the pseudo first order rate constant for the hydrolysis of ester.
23. A washer woman while washing napkins of babies found that some of the dirt particles settled down at bottom of the water tub, while some other particles stuck to the froth (soap suds) and came to the top. The washer woman reported this phenomenon to one of her clients who was a chemist. This observation led to the discovery of very good step used in metallurgy. Now answer the following questions :
- Name the step of metallurgy discovered on the basis of this observation.
  - What is the reason for this observation?
  - Name the two ores which can be concentrated by the given method.
  - What values do you learn from this episode?
24. (i) Knowing the electron gain enthalpy values for  $\text{O} \rightarrow \text{O}^-$  and  $\text{O} \rightarrow \text{O}^{2-}$  as  $-141$  and  $702 \text{ kJ mol}^{-1}$  respectively, how can you account for the formation of large number of oxides having  $\text{O}^{2-}$  species and not  $\text{O}^-$  ?  
[Consider lattice energy factor in the formation of compound.]
- (ii) On heating, lead (II) nitrate gives a brown gas 'A'. The gas 'A' on cooling changes to colourless solid 'B'. Solid 'B' on heating with NO changes to a blue solid 'C'. Identify 'A', 'B' and 'C' and



also write reactions involved and draw the structures of 'B' and 'C'.

OR

- (i) Write the reactions of  $F_2$  and  $Cl_2$  with water.
  - (ii) How are  $XeO_3$  and  $XeOF_4$  prepared?
  - (iii) Why is red phosphorus less reactive than white phosphorus?
25. (i) Give the order of depression in freezing point of water for the same molar concentrations of acetic acid, trichloroacetic acid and trifluoroacetic acid. Give reason also.
- (ii) Calculate the depression in freezing point of water when 20.0 g of  $CH_3CH_2CHClCOOH$  is added to 500 g of water.  
[Given :  $K_a = 1.4 \times 10^{-3}$ ,  $K_f = 1.86 \text{ K kg mol}^{-1}$ ]

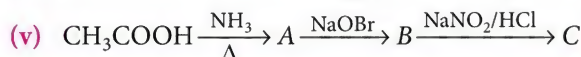
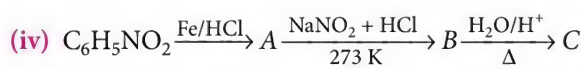
OR

- (i) Assuming complete dissociation, calculate the expected freezing point of a solution prepared by dissolving 6.00 g of Glauber's salt,  $Na_2SO_4 \cdot 10H_2O$  in 0.100 kg of water.  
( $K_f$  for water =  $1.86 \text{ K kg mol}^{-1}$ , atomic masses of Na = 23, S = 32, O = 16, H = 1)
  - (ii) Phenol associates in benzene to a certain extent to form a dimer. A solution containing 20 g of phenol in 1.0 kg of benzene has its freezing point lowered by 0.69 K. Calculate the fraction of phenol that has dimerised.  
(Given :  $K_f$  for benzene =  $5.1 \text{ K m}^{-1}$ )
26. (i) Suggest chemical reactions for the following conversions :
- (a) Aniline to benzoic acid.
  - (b) *n*-Hexanenitrile to 1-aminopentane.
  - (c) *p*-Chloroaniline to *p*-chlorobenzylamine.
- (ii) Account for the following :
- (a) Aqueous solution of methyl amine reacts with iron (III) chloride to precipitate iron (III) hydroxide.
  - (b) The boiling points of amines are lower than those of corresponding alcohols.

OR

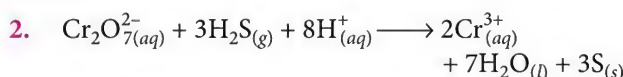
Give the structures of A, B and C in the following reactions :

- (i)  $CH_3CH_2I \xrightarrow{NaCN} A \xrightarrow[\text{Partial hydrolysis}]{OH^-} B$
- (ii)  $C_6H_5N_2Cl \xrightarrow{CuCN} A \xrightarrow{H_2O/H^+} B \xrightarrow[\Delta]{NH_3} C$
- (iii)  $CH_3CH_2Br \xrightarrow{KCN} A \xrightarrow{LiAlH_4} B \xrightarrow[0^\circ C]{HNO_2} C$



## SOLUTIONS

1. Enzymes are termed as biocatalysts as they help in catalysis of biological reactions. For example, inversion of cane sugar is carried out with the help of invertase enzyme.



3. (i) They do not cause any pollution.
- (ii) They have high efficiency of 60-70%.

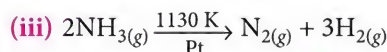
4. The presence of traces of electrolyte is essential for the stability of the colloidal solution but larger quantities coagulate it so, it is necessary to purify it.

$$5. \Lambda_m = \frac{\kappa \times 1000}{M}$$

where,  $\kappa$  is the conductivity,  $M$  is the molar concentration and  $\Lambda_m$  is molar conductivity.

6. (i) The reaction is of zero order.

$$(ii) \text{Slope} = -k = \frac{d[R]}{dt}$$



OR

(i) Order of reaction is sum of powers of concentration terms.

$$\therefore \text{Order of reaction} = 1 + 2 = 3$$

$$(ii) k_1 = \frac{2.303}{t} \log \frac{[R]_0}{[R]}$$

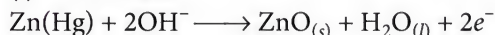
where  $[R]_0$  = Initial concentration

$[R]$  = Concentration at time  $t$

Unit of rate constant for first order reaction is  $s^{-1}$ .

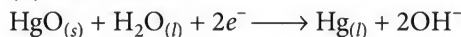
7. The cell reactions are as follows :

(i) At anode :

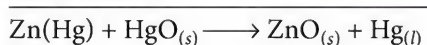


(Amalgam)

(ii) At cathode :



Net reaction :

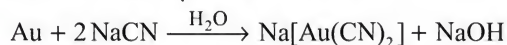


The cell potential remains constant during its operation as the overall reaction does not involve any ion in solution whose concentration can change during its use.

8. Gold is extracted by hydrometallurgy.

(i) Gold is extracted from quartz stone. Quartz is broken into chips and powdered.

(ii) Powdered ore is treated with dilute aqueous solution of sodium cyanide and filtered.



(iii) Filtrate is treated with more active metal to give gold.



9. (i) Magnetic moment is determined by the number of unpaired electrons by using the following formula :

$$\mu = \sqrt{n(n+2)} \text{ B.M.}$$

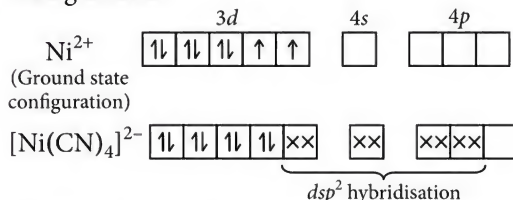
where,  $n$  = number of unpaired electrons.

(ii)  $\text{Z} (25) : [\text{Ar}] 3d^5 4s^2$

It has 5 unpaired electrons,  $n = 5$

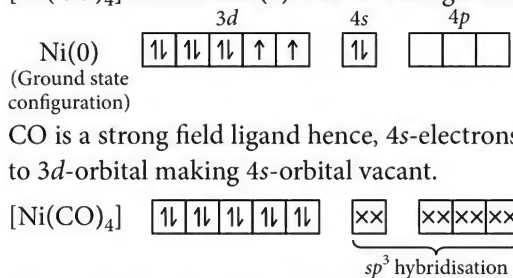
$$\therefore \mu = \sqrt{n(n+2)} = \sqrt{5(5+2)} = \sqrt{35} = 5.92 \text{ B.M.}$$

10. In  $[\text{Ni}(\text{CN})_4]^{2-}$ , Ni is present as Ni(II) with  $3d^8$  configuration.

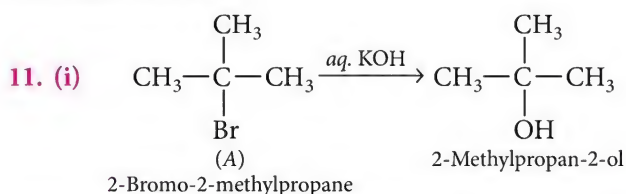


The complex ion has square planar geometry and is diamagnetic in nature.

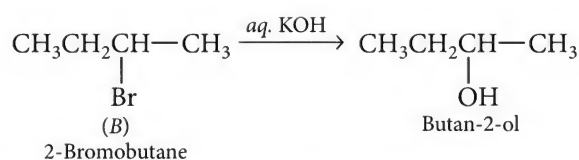
$[\text{Ni}(\text{CO})_4]$  contains Ni(0) :  $3d^8 4s^2$  configuration.



The complex ion has tetrahedral geometry and is diamagnetic in nature.



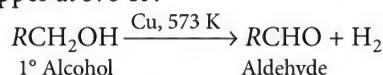
Compound (A) being a tertiary halide, undergoes  $\text{S}_\text{N}1$  substitution hence, depends on concentration of one reactant only.



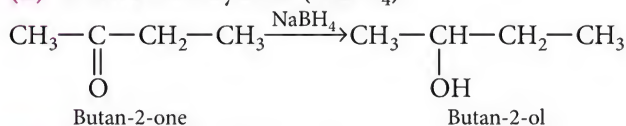
Compound (B) undergoes  $\text{S}_\text{N}2$  nucleophilic substitution which is bimolecular and rate depends upon the concentration of both reactants.

(ii) Compound (B) will be converted to product with inverted configuration.

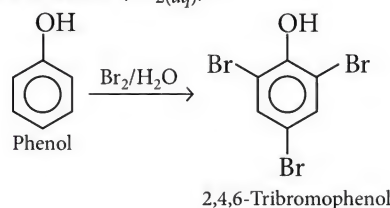
12. (i) Copper at 573 K :



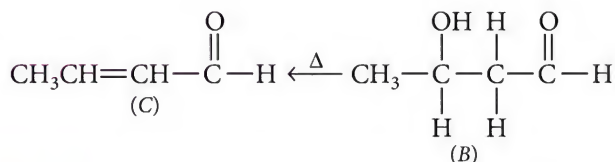
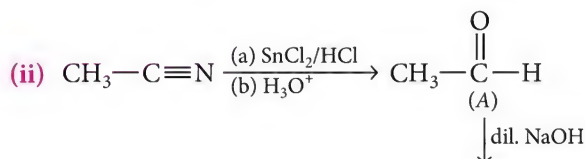
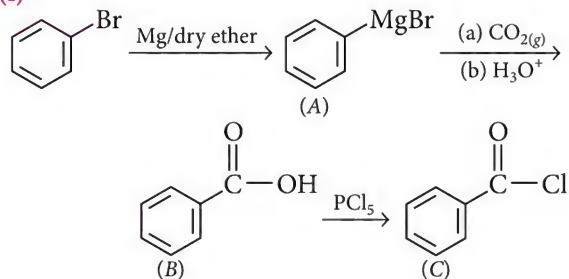
(ii) Sodium borohydride ( $\text{NaBH}_4$ ) :



(iii) Bromine water ( $\text{Br}_{2(\text{aq})}$ ) :



13. (i)



14. (i)  $\alpha$  - Helix structure : In this type of structure, the long peptide chains undergo formation of H - bonding between the  $-\text{C}(=\text{O})-$  and  $-\text{N}-$  of different



peptide groups within the same chain. As a result, the polypeptide chain gets coiled up to form a right handed helix.

**$\beta$ -Pleated sheet :** In this structure, the long peptide chains lie side by side to form a flat sheet. Each chain is held by the two neighbouring chains by H-bonds (N - H ..... OC).

(ii) Primary structure of protein refers to the arrangement of  $\alpha$ -amino acids in the polypeptide chain. Secondary structure of protein is the arrangement of polypeptide chains.

(iii) Enzymes are biological catalysts which catalyse the various biochemical reactions in the body. Chemically, all enzymes are globular proteins. The non-protein part called prosthetic group such as small organic molecules with which the enzymes are associated are called co-enzymes.

#### 15. (i) Polythene :

Monomer - Ethene :  $\text{CH}_2=\text{CH}_2$

Structure of polymer :  $\{ \text{CH}_2 - \text{CH}_2 \}_n$

**Uses :** It is used as an insulator and as an anticorrosive material. It is used in packing material, household and laboratory wares.

#### (ii) Polystyrene :

Monomer - Styrene :  $\text{CH}=\text{CH}_2$



Structure of polymer :  $\left[ \text{HC} - \text{CH}_2 \right]_n$



**Uses :** It is used as an insulator and in wrapping material, manufacture of toys and household articles.

#### (iii) PVC (Polyvinyl chloride) :

Monomer - Vinyl chloride (Chloroethene) :

$\text{CH}_2=\text{CH}-\text{Cl}$

Structure of polymer :  $\left( \text{CH}_2 - \underset{\text{Cl}}{\text{CH}} \right)_n$

**Uses :** It is used in manufacture of raincoats, handbags, vinyl flooring and leather clothes.

16. Let the formula of sample be  $(\text{Fe}^{2+})_x (\text{Fe}^{3+})_y \text{O}$ .

From the formula of the compound,

$$x + y = 0.93 \quad \dots(i)$$

Total positive charge on  $\text{Fe}^{2+}$  and  $\text{Fe}^{3+}$  should balance the two units of negative charge on oxygen. Hence,

$$2x + 3y = 2$$

$$\Rightarrow x + \frac{3}{2}y = 1 \quad \dots(ii)$$

On subtracting equation (i) from (ii), we get

$$\frac{3}{2}y - y = 1 - 0.93 \Rightarrow \frac{1}{2}y = 0.07$$

$$\Rightarrow y = 0.14$$

On putting the value of  $y$  in equation (i),

$$x + 0.14 = 0.93 \Rightarrow x = 0.93 - 0.14$$

$$\text{or } x = 0.79$$

$$\text{Fraction of } \text{Fe}^{2+} \text{ ions present in the sample} = \frac{0.79}{0.93} = 0.849$$

Metal deficiency defect is present in the sample because iron present is less in amount than that required for stoichiometric composition.

**OR**

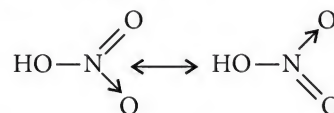
(i) The crystalline solids have sharp melting points.

Melting point of a solid is related to the force of attraction between its molecules. Higher the melting point of a crystalline substance, greater is the force between the constituent particles and hence, greater is the stability.

(ii) (a) Frenkel defect is not found in alkali metal halides because the ions cannot get into the interstitial sites due to their larger size.

(b) Schottky defects occur when cations and anions are missing from their lattice sites. Mass of unit cell decreases which decreases the density of the solid.

17. (i)  $\text{HNO}_3$  is supposed to exist in two resonating forms. Due to two resonating structures, N - O bond is shorter than N - OH bond.

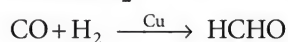
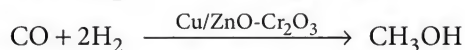
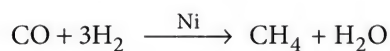


(ii)  $\text{P}_4 + \text{H}_2\text{O} \longrightarrow \text{No reaction}$

(iii) Sulphur exists in numerous allotropic forms out of which yellow rhombic ( $\alpha$ -sulphur) and monoclinic ( $\beta$ -sulphur) are most important. The rhombic form is stable at room temperature, which transforms to monoclinic sulphur, when heated around 370 K.

18. (i) **Activity :** The activity of a catalyst depends upon the strength of chemisorption to a large extent. The reactants must get adsorbed reasonably strongly on to the catalyst to become active. But adsorption must not be so strong that they are immobilised. It is observed that maximum activity is shown by elements of groups 7-9 of the periodic table.

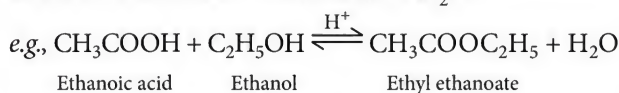
**Selectivity :** The selectivity of a catalyst is its ability to yield a particular product in the reaction e.g.,



Thus, a selective catalyst can act as a catalyst in one reaction and may fail to catalyse another reaction.

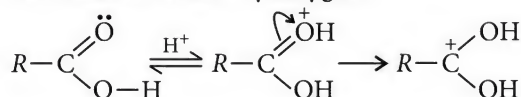
(ii) According to Hardy—Schulze rule, the greater the valency of flocculating ion added, the greater is its power to cause precipitation. In coagulation of a positive sol the flocculating power is in the order :  $\text{PO}_4^{3-} > \text{SO}_4^{2-} > \text{Cl}^-$ .

**19. Esterification :** Carboxylic acids react with alcohols or phenols in the presence of a mineral acid like concentrated  $\text{H}_2\text{SO}_4$  or  $\text{HCl}$  gas as catalyst and give esters.

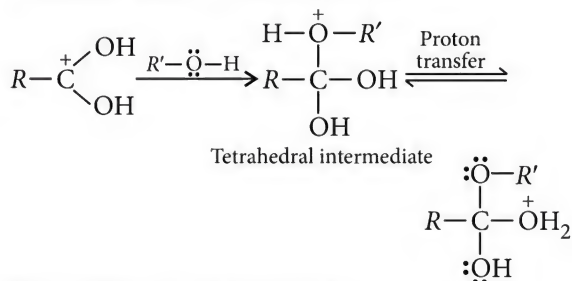


**Mechanism of esterification :** It is a nucleophilic acyl substitution.

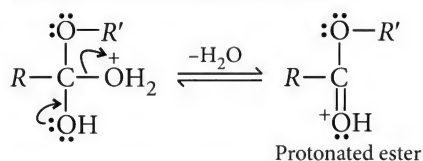
(a) Protonation of carboxyl oxygen :



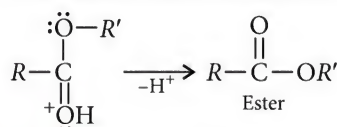
(b) Nucleophilic addition of alcohol :



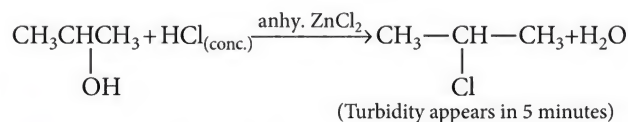
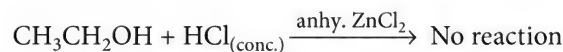
(c) Elimination of water molecule :



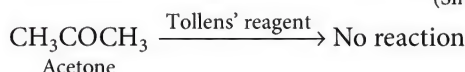
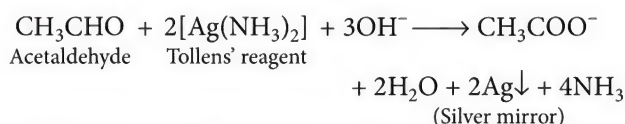
(d) Protonated ester loses a proton to give ester :



**20. (i) (a)** Treat the compound with Lucas reagent (conc.  $\text{HCl}$  + anhy.  $\text{ZnCl}_2$ ). 2-Propanol gives turbidity in 5 minutes whereas ethanol gives no turbidity at room temperature.



(b) Acetaldehyde reduces Tollens' reagent to silver mirror but acetone does not.



(ii) 99.5% ethanol is known as absolute alcohol.

**21. Given :** Diameter = 1 cm, length = 50 cm

$$R = 5.5 \times 10^3 \text{ ohm}, M = 0.05 \text{ M}$$

$$\rho = ? \quad \kappa = ? \quad \Lambda_m = ?$$

$$\text{Area of the column, } a = \pi r^2 = 3.14 \times \left(\frac{1}{2} \text{ cm}\right)^2 = \frac{3.14}{4} \text{ cm}^2$$

$$\text{Resistivity } (\rho) = R \cdot \frac{a}{l} = 5.5 \times 10^3 \text{ ohm} \times \frac{3.14 \text{ cm}^2}{4 \times 50 \text{ cm}} = 86.35 \text{ ohm cm}$$

$$\text{Again, conductivity } (\kappa) = \frac{1}{\rho} = \frac{1}{86.35} = 1.158 \times 10^{-2} \text{ ohm}^{-1} \text{ cm}^{-1}$$

$$\text{and molar conductivity } (\Lambda_m) = \kappa \cdot \frac{10^3}{M} = 1.158 \times 10^{-2} \times \frac{10^3}{5 \times 10^{-2}} = 231.6 \text{ ohm}^{-1} \text{ cm}^2 \text{ mol}^{-1}$$

**22. (i)** Average rate of reaction between the time interval 30 to 60 seconds is

$$r_{av} = \frac{-[0.17 - 0.31]}{60 - 30} = \frac{0.14}{30} = 4.67 \times 10^{-3} \text{ s}^{-1}$$

$$(ii) \quad k = \frac{2.303}{t} \log \frac{[R]_0}{[R]}$$

At  $t = 30 \text{ s}$ ,

$$k = \frac{2.303}{30} \log \frac{0.55}{0.31} = \frac{2.303}{30} \times 0.249 = 1.91 \times 10^{-2} \text{ s}^{-1}$$

At  $t = 60 \text{ s}$ ,

$$k = \frac{2.303}{60} \log \frac{0.55}{0.17} = \frac{2.303}{60} \times 0.5099 = 1.96 \times 10^{-2} \text{ s}^{-1}$$



At  $t = 90$  s

$$k = \frac{2.303}{90} \log \frac{0.55}{0.085} = \frac{2.303}{90} \times 0.8109 = 2.07 \times 10^{-2} \text{ s}^{-1}$$

$\therefore$  Average value of  $k$

$$= \frac{1.91 \times 10^{-2} + 1.96 \times 10^{-2} + 2.07 \times 10^{-2}}{3}$$

$$= 1.98 \times 10^{-2} \text{ s}^{-1}$$

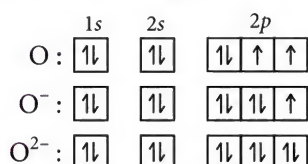
**23. (i)** Froth floatation process used for concentration of metal ore is based on this observation.

**(ii)** The dirt which is wet by water becomes heavy and settle down. Whereas the metal compounds which are not wet by water stick to the froth and float in the upper surface.

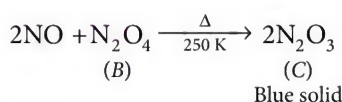
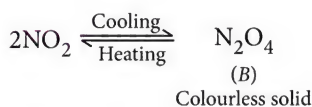
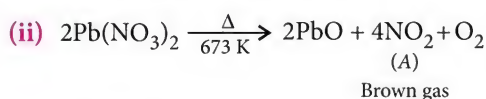
**(iii)** Zinc blende (ZnS) and copper pyrites (CuFeS<sub>2</sub>)

**(iv)** Careful observation of any small phenomenon may lead to useful discoveries.

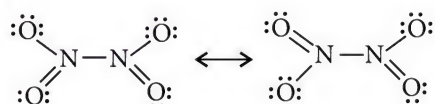
**24. (i)** This can be explained with the help of electronic configuration.



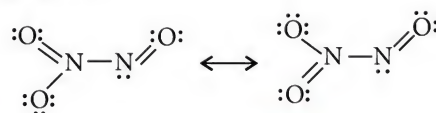
As O<sup>2-</sup> has most stable configuration amongst these. So, formation of O<sup>2-</sup> is much more easier. In solid state, large amount of energy (lattice enthalpy) is released to form divalent O<sup>2-</sup> ions. It is greater lattice enthalpy of O<sup>2-</sup> which compensates for the high energy required to remove the second electron.



**N<sub>2</sub>O<sub>4</sub> (B) :**

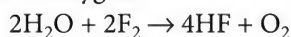


**N<sub>2</sub>O<sub>3</sub> (C) :**

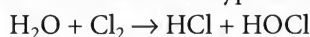


**OR**

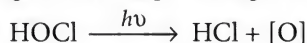
**(i)** Fluorine reacts vigorously with water and oxidises water to oxygen.



Chlorine dissolves in water to form chlorine water. It slowly reacts with the water to form a mixture of hydrochloric acid and hypochlorous acid.

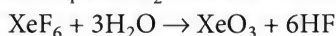
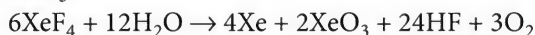


Hypochlorous acid is very unstable. In presence of sunlight, it decomposes to give HCl and nascent oxygen.

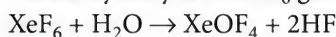


This nascent oxygen is responsible for oxidising and bleaching properties of chlorine.

**(ii)** Hydrolysis of XeF<sub>4</sub> and XeF<sub>6</sub> with water gives XeO<sub>3</sub>.

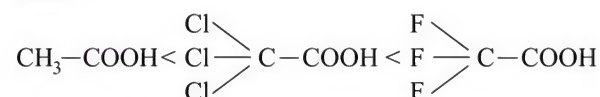


Partial hydrolysis of XeF<sub>6</sub> gives oxyfluoride, XeOF<sub>4</sub>.



**(iii)** White phosphorus is more reactive than red phosphorus under normal conditions because of angular strain in the P<sub>4</sub> molecule where the angles are only 60°.

**25. (i)** The depression in freezing points are in the order :



Acetic acid      Trichloroacetic acid      Trifluoroacetic acid

Fluorine being most electronegative, has the highest electron withdrawing inductive effect. Consequently, trifluoroacetic acid is the strongest acid while acetic acid is the weakest acid. Hence, trifluoroacetic acid ionises to the largest extent while acetic acid ionises to the minimum extent to give ions in their solutions in water. Greater the ions produced, greater is the depression in freezing point. Hence, the depression in freezing point is maximum for trifluoroacetic acid and minimum for acetic acid.

**(ii)** Given mass of CH<sub>3</sub>CH<sub>2</sub>CHClCOOH = 20 g

Molar mass of CH<sub>3</sub>CH<sub>2</sub>CHClCOOH

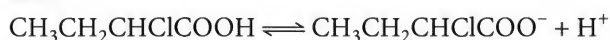
$$= 15 + 14 + 13 + 35.5 + 45 = 122.5 \text{ g mol}^{-1}$$

Number of moles of  $\text{CH}_3\text{CH}_2\text{CHClCOOH}$

$$= \frac{20 \text{ g}}{122.5 \text{ g mol}^{-1}} = 0.1632 \text{ mol}$$

$$\text{Molality of the solution } (m) = \frac{0.1632}{500} \times 1000 = 0.3264 \text{ m}$$

If  $\alpha$  be the degree of dissociation of  $\text{CH}_3\text{CH}_2\text{CHClCOOH}$  then



Initial conc :  $C$   $C\alpha$   $C\alpha$

At equilibrium :  $C(1 - \alpha)$   $C\alpha$   $C\alpha$

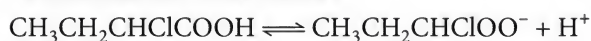
$$K_a = \frac{C\alpha \times C\alpha}{C(1 - \alpha)} = \frac{C^2\alpha^2}{C(1 - \alpha)} \approx C\alpha^2$$

$$\therefore K_a = C\alpha^2$$

$$\alpha = \sqrt{\frac{K_a}{C}} = \sqrt{\frac{1.4 \times 10^{-3}}{0.3264}} = \sqrt{0.004289} = 0.065$$

$$\therefore \alpha = 0.065$$

To calculate van't Hoff factor :



Initial mol. :  $1$   $0$   $0$

Moles at eq. :  $1 - \alpha$   $\alpha$   $\alpha$

$$\text{Total number of moles} = 1 - \alpha + \alpha + \alpha = 1 + \alpha = 1 + 0.065 = 1.065$$

$$\therefore \Delta T_f = iK_f m = (1.065)(1.86)(0.3264) = 0.65 \text{ K}$$

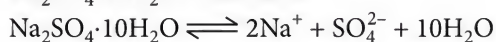
Hence, depression in freezing point of water = 0.65 K

OR

(i) Molecular mass of Glauber's salt  $\text{Na}_2\text{SO}_4 \cdot 10\text{H}_2\text{O}$

$$= [2 \times 23 + 32 + 16 \times 4 + 10 \times (2 \times 1 + 16)] = (46 + 32 + 64 + 180) \text{ g mol}^{-1} = 322 \text{ g mol}^{-1}$$

$\text{Na}_2\text{SO}_4 \cdot 10\text{H}_2\text{O}$  ionises as :



$$\Rightarrow i = 3$$

$$m = \frac{n_B}{W_{A(\text{in kg})}} = \frac{W_B}{M_B \times W_{A(\text{in kg})}} = \frac{6.00 \text{ g}}{322 \text{ g mol}^{-1} \times 0.1 \text{ kg}} = 0.186 \text{ mol kg}^{-1} = 0.186 \text{ m}$$

$$\text{Also, } \Delta T_f = iK_f \cdot m$$

$$= 3 \times 1.86 \text{ K m}^{-1} \times 0.186 \text{ m} = 1.04 \text{ K}$$

$$\Rightarrow T_f = T_f^\circ - \Delta T_f = (273 - 1.04) \text{ K} = 271.96 \text{ K}$$

(ii) Here,  $n = 2$  because phenol forms dimer on association.

$$W_2 = 20 \text{ g}, W_1 = 1 \text{ kg} = 1000 \text{ g}, \Delta T_f = 0.69 \text{ K},$$

$$K_f = 5.1 \text{ K m}^{-1}$$

$$\Delta T_f = \frac{K_f \times W_2 \times 1000}{M_2 \times W_1}$$

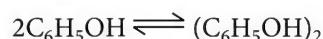
$$M_2 = \frac{K_f \times W_2 \times 1000}{\Delta T_f \times W_1} = \frac{5.1 \times 20 \times 1000}{0.69 \times 1000} = 147.82 \text{ g mol}^{-1}$$

$$M_{2(\text{observed})} = 147.82 \text{ g mol}^{-1}$$

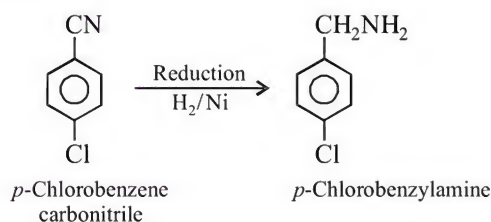
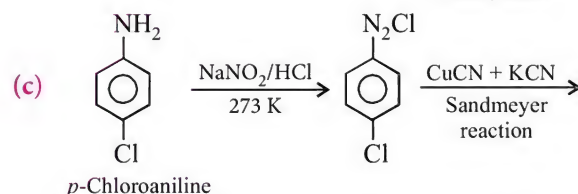
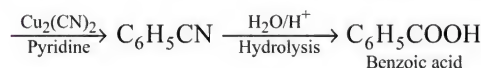
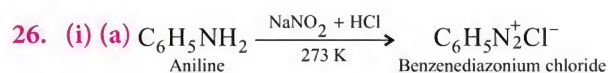
$M_{2(\text{calculated})}$  :

$$\text{C}_6\text{H}_5\text{OH} = 6 \times 12 + 6 \times 1 + 16 = 94 \text{ g mol}^{-1}$$

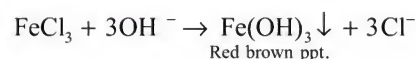
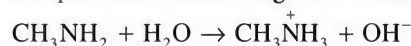
$$i = \frac{M_{2(\text{calculated})}}{M_{2(\text{observed})}} = \frac{94}{147.82} = 0.635$$



$$\alpha = \frac{i - 1}{\left(\frac{1}{n} - 1\right)} = \frac{0.635 - 1}{\left(\frac{1}{2} - 1\right)} = \frac{0.365}{0.5} = 0.73 = 73\%$$



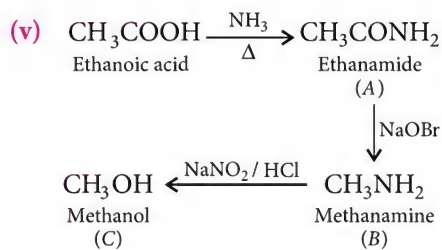
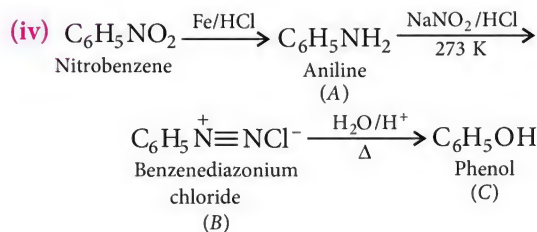
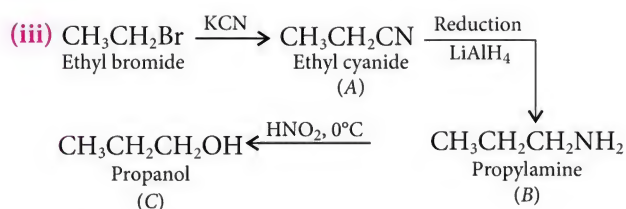
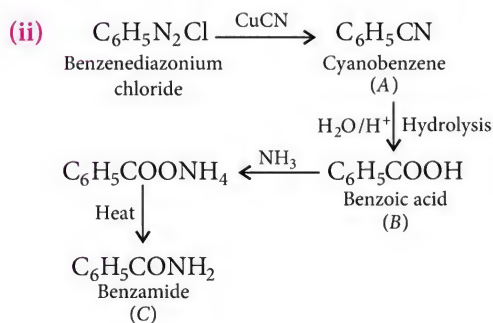
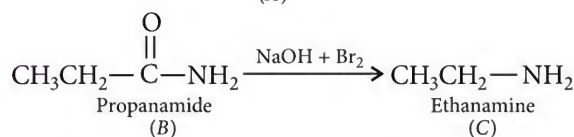
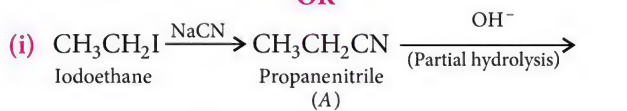
(ii) (a) Methylamine reacts with water to form methyl ammonium hydroxide which is more basic than  $\text{NH}_4\text{OH}$  and ionises to give  $\text{OH}^-$  ions.





(b) As oxygen is more electronegative than nitrogen therefore, hydrogen bonding among alcohol molecules is stronger than among amine molecules. So, alcohols have higher boiling points than amines.

OR



# MPP-10 MONTHLY Practice Problems

Class XII

This specially designed column enables students to self analyse their extent of understanding of specified chapters. Give yourself four marks for correct answer and deduct one mark for wrong answer. Self check table given at the end will help you to check your readiness.

## Biomolecules | Polymers | Chemistry in Everyday Life

Total Marks : 120

Time Taken : 60 Min.

### NEET / AIIMS

#### Only One Option Correct Type

- The process of formation of RNA from DNA is known as  
(a) translation (b) transcription  
(c) replication (d) mutation.
- The species which cannot serve as an initiator for the free radical polymerisation is  
(a)  $\text{Ph}-\text{C}(=\text{O})-\text{O}-\text{O}-\text{C}(=\text{O})-\text{Ph}$   
(b)  $\text{H}_3\text{C}-\text{C}(\text{CN})=\text{N}=\text{N}-\text{C}(\text{CN})-\text{CH}_3$   
(c)  $\text{Ph}-\text{C}(=\text{O})-\text{C}(=\text{O})-\text{Ph}$  (d)  $\text{Ph}-\text{CH}_2-\text{C}(=\text{O})-\text{H}$
- Which of the following statements is not correct?  
(a) Soaps act by lowering surface tension between water and oil or insoluble material.  
(b) Soap forms insoluble salt with  $\text{Ca}^{2+}$  ions.  
(c) The  $\text{COO}^-$  group in soaps acts as hydrophilic and alkyl chain as hydrophobic.  
(d) Soaps work more efficiently in hard water than in soft water.
- Which amino acid is achiral?  
(a) Alanine (b) Valine  
(c) Histidine (d) None of these
- Which of the following are polysaccharides?  
(i) Starch (ii) Cellulose  
(iii) Dextrins (iv) Glycogen  
(a) (i), (ii) and (iii) only  
(b) (i), (ii) and (iv) only  
(c) (i) and (iii) only (d) All of these
- Which of the following is used as sedative?  
(a) Paracetamol (b) Chloroquine  
(c) Bithional (d) Barbituric acid derivatives
- Di-*n*-butylphthalate is a  
(a) plasticizer (b) thermoplastic  
(c) polymer (d) thermosetting plastic.
- The role of zinc stearate in the process of vulcanisation is  
(a) to accelerate the process  
(b) to slow down the process  
(c) to stop the process  
(d) to initiate the process.
- In an amino acid, the carboxyl group ionises at  $\text{p}K_{a1} = 2.34$  and ammonium ion at  $\text{p}K_{a2} = 9.60$ . The isoelectric point of the amino acid is at pH  
(a) 5.97 (b) 2.34  
(c) 9.60 (d) 6.97
- Receptors as drug targets are proteins that are crucial to body's communication process. They are embedded in the  
(a) brain (b) enzyme  
(c) skin (d) cell membrane.
- The substance used to harden the rubber for tyre manufacture is  
(a) wax (b) 1,3-butadiene  
(c) calcium carbide (d) carbon black.



12. Barbiturates exert depressant action on  
(a) gut (b) heart  
(c) cerebrospinal axis (d) all of these.

#### Assertion & Reason Type

**Directions :** In the following questions, a statement of assertion is followed by a statement of reason. Mark the correct choice as :

- (a) If both assertion and reason are true and reason is the correct explanation of assertion.  
(b) If both assertion and reason are true but reason is not the correct explanation of assertion.  
(c) If assertion is true but reason is false.  
(d) If both assertion and reason are false.

13. **Assertion :** Millon's test is a test for identification of proteins.

**Reason :** Millon's reagent is a solution of mercurous nitrate and mercuric nitrate in nitric acid containing little nitrous acid.

14. **Assertion :** Sodium dodecylbenzenesulphonate is a biodegradable detergent.

**Reason :** Detergents having highly branched chains, are biodegradable.

15. **Assertion :** Ozonolysis of polyisoprene gives 4-oxopentanal as one of the products.

**Reason :** Ozonolysis of polyisoprene involves elimination followed by hydrolysis.

#### JEE MAIN / JEE ADVANCED

#### Only One Option Correct Type

16. The substituted pyrimidine is  
(a) adenine (b) cytosine  
(c) guanine (d) none of these.
17. Chloramine – T is a /an  
(a) tranquilizer (b) antiseptic  
(c) analgesic (d) antipyretic.
18. Cheilosis and digestive disorders are due to the deficiency of  
(a) ascorbic acid (b) pyridoxine  
(c) thiamine (d) riboflavin.
19. The fibre used for the manufacture of cords and carpets is  
(a) polyethylene  
(b) polypropylene  
(c) polyacrylonitrile  
(d) polyvinyl chloride.

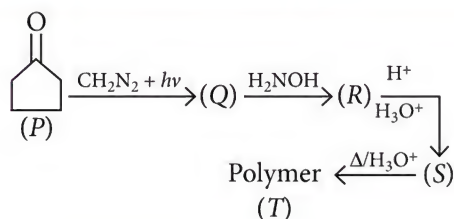
### More than One Options Correct Type

20. Which of the following can be used as plasticizers?  
 (a) Cresyl phthalate (b) Diethyl phthalate  
 (c) Polystyrene (d) Trimethylphosphate
21. Which of the following statements are not correct?  
 (a) A polymer of  $\alpha$ -glucose is readily digested by human beings and not that of  $\beta$ -glucose.  
 (b) A polymer of  $\beta$ -glucose is readily digested by human beings and not that of  $\alpha$ -glucose.  
 (c) Polymers of both  $\alpha$ - and  $\beta$ -glucoses are readily digested by human beings.  
 (d) Polymers of both  $\alpha$ - and  $\beta$ -glucose are not readily digested by human beings.
22. Which of the following are chromophores?  
 (a)  $-\text{N}=\text{N}-$  (b)  $-\text{NO}$   
 (c)  $-\text{NO}_2$  (d)  $-\text{NH}_2$
23. Which of the following contain transition metal?  
 (a) Vitamin  $\text{B}_{12}$  (b) Chlorophyll  
 (c) Haemoglobin (d) DNA

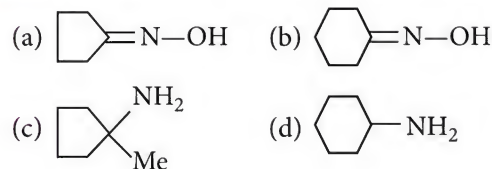
### Integer Answer Type

24. A sequence of how many nucleotides in messenger RNA makes a codon for an amino acid?
25. Find out the number of non-narcotic analgesics among the following:  
 aspirin, ibuprofen, morphine, heroin, diclofenac sodium, paracetamol, codeine, naproxen.
26. The total number of lone pairs of electrons in melamine is

### Comprehension Type



27. Compound (R) is



28. The compound (T) is

- (a) nylon-6, 10 (b) nylon-5  
 (c) nylon-6 (d) dacron.

### Matrix Match Type

29. Match the List I with List II and select the correct answer using the codes given below the lists :

List I				List II	
P.	Anti-beriberi factor	1.	Vitamin C		
Q.	Pancreas	2.	Glycerides		
R.	Palm oil	3.	Vitamin $\text{B}_1$		
S.	L-Ascorbic acid	4.	Insulin		
P	Q	R	S		
(a)	3	4	2	1	
(b)	3	4	1	2	
(c)	1	2	4	3	
(d)	1	2	3	4	

30. Match the List I with List II and select the correct answer using the codes given below the lists :

List I				List II	
P.	Iodoform	1.	Anaesthetic		
Q.	Methyl salicylate	2.	Antiseptic		
R.	Diethyl ether	3.	Insecticide		
S.	Hexachlorocyclohexane	4.	Detergent		
		5.	Pain balm		
P	Q	R	S		
(a)	2	5	3	4	
(b)	4	2	1	3	
(c)	2	5	1	3	
(d)	3	1	4	2	



Keys are published in this issue. Search now! ☺

## SELF CHECK

No. of questions attempted .....  
 No. of questions correct .....  
 Marks scored in percentage .....

### Check your score! If your score is

> 90%	EXCELLENT WORK !	You are well prepared to take the challenge of final exam.
90-75%	GOOD WORK !	You can score good in the final exam.
74-60%	SATISFACTORY !	You need to score more next time.
< 60%	NOT SATISFACTORY!	Revise thoroughly and strengthen your concepts.



# DR. G. VISWANATHAN UNANIMOUSLY ELECTED INDIAN ECONOMIC ASSOCIATION CONFERENCE PRESIDENT



Founder Chancellor of Vellore Institute of Technology (VIT), Dr. G.Viswanathan has been unanimously elected as President of the Centenary Second Year Conference of the Indian Economic Association.

The First Year of the Centenary Celebrations was held at Acharya Nagarjuna University in Guntur, Andhra Pradesh between December 27 and 30, 2017. The selection was made during the General Body to be President of Centenary Second Year Conference of IEA.

Mr. Ram Nath Kovind, President of India, inaugurated the first year centenary celebrations at Acharya Nagarjuna University. E.S.L.Narasimhan, Governor of Andhra Pradesh, Chandrababu Naidu, Chief Minister, Muhammad Yunus, Nobel Laureate for Peace and Founder of Grameen Bank, former RBI Governor C.Rangarajan were among others present on the occasion in the inaugural function.

In his address, Mr. Kovind called upon emerging economies, including India, to speak up for an interconnected world with a fair and growing trade, in the wake of some countries turning protectionist. He also said imaginative policy-making was required to overcome the social and economic inequalities between different sections and regions.

During the Conference, Dr. G. Viswanathan presided over a special lecture by Prof Jomo Kwane Sundaram, a leading World Bank and United Nations economist from Malaysia. Mr. Sundaram spoke on the importance of trade for economic development. Dr G.Viswanathan stated that good politics should ensure cooperation among numerous political parties of India to have a common development agenda and clean politics free from corruption. He invited the IEA to guide the nation with good ideas for optimum use of public expenditure and allied fiscal policies.

The IEA was founded by Dr. Gilbert Slater, First Professor of Indian Economics, University of Madras along with Prof. Percy Anstey and C.J. Hamilton of Bombay and Calcutta Presidency Universities in 1917, along with Madras Economic Association. Former Presidents of IEA include former Prime Minister Dr. Manmohan Singh, Nobel Laureate Dr. Amartya Sen, Nobel Laureate, Dr. G.Patel, Director, London School of Economics and Political Science, Vice Chancellors Dr. V.K.R.V. Rao, Dr. Malcolm S Adiseshiah and Dr Yasodha Shanmugasundaram among others.

☺☺